Nuclear Energy

Nuclear Energy

Table of Contents

Energy Supply
Office of Nuclear Energy, Science and Technology

Overview

Appropriation Summary by Program

(dollars in thousands)

	FY 2004 Comparable Appropriation	FY 2005 Original Appropriation	FY 2005 Adjustments	FY 2005 Comparable Appropriation	FY 2006 Request
Energy Supply					
University Reactor Infrastructure and Education Assistance	23,055	24,000	-190[a]	23,810	24,000
Research and Development					
Nuclear Energy Plant Optimization	2,863	2,500	-20[a]	2,480	0
Nuclear Energy Research Initiative	6,410	2,500	-19[a]	2,481	0
Nuclear Power 2010	19,360	50,000	-395[a]	49,605	56,000
Generation IV Nuclear Energy Systems Initiative	26,981	40,000	-317[a]	39,683	45,000
Nuclear Hydrogen Initiative	6,201	9,000	-71[a]	8,929	20,000
Advanced Fuel Cycle Initiative	65,750	68,000	-538[a]	67,462	70,000
Total, Research and Development	127,565	172,000	-1,360	170,640	191,000
Infrastructure					
Radiological Facilities Mgmt	63,431	69,110	-547[a]	68,563	64,800
Idaho Facilities Management	75,534	123,050	-730[a]	122,320	80,100
Idaho Sitewide Safeguards and Security	56,654	58,103	0	58,103	0
Total, Infrastructure	195,619	250,263	-1,277	248,986	144,900
Spent Nuclear Fuel Management	0	6,723[b]	-6,723[b]	0	0
Program Direction	60,256	60,285	+89[c]	60,374	30,006
Subtotal, Energy Supply	406,495	513,271	-9,461	503,810	389,906

[a] Distribution of the rescission from the Consolidated Appropriations Act, 2005.
[b] Amount includes $5.223M Energy Supply and $1.5M for Other Defense Activities that are being transferred to the Office of Environmental Management.
[c] Amount includes comparability adjustments of $209K for the rescission in the Consolidated Appropriations Act, 2005, $97K for one FTE transfer to the Office of the Chief Information Officer, and $395K for 2 FTEs from the National Nuclear Security Administration.

(dollars in thousands)

	FY 2004 Comparable Appropriation	FY 2005 Original Appropriation	FY 2005 Adjustments	FY 2005 Comparable Appropriation	FY 2006 Request
Use of Prior-Year Balances	0	-4,217[a]	0	-4,217	0
Less Security Charge for Reimbursable Work	-3,003	0	0	0	0
Funding from Other Defense	-112,306	-114,347	0	-114,347	0
Funding from Naval Reactors	0	-10,000	0	-10,000	0
Total, Energy Supply	291,186	384,707	-9,461	375,246	389,906
Other Defense Activities					
Infrastructure					
Idaho Facilities Management	21,296	20,886	-167[b]	20,719	17,762
Idaho Sitewide Safeguards and Security	56,343	58,103	-441[b]	57,662	75,008
Total, Infrastructure	77,639	78,989	-608	78,381	92,770
Spent Nuclear Fuel Management	0	1,500[c]	-12[b]	1,488[c]	0
Program Direction	33,979	33,858	-339[d]	33,519	31,103
Subtotal, Other Defense Activities	111,618	114,347	-959	113,388	123,873
Less Security Charge for Reimbursable Work	0	-3,003	0	-3,003	-3,003
Total, Other Defense Activities	111,618	111,344	-959	110,385	120,870
Total, Energy Supply and Other Defense Activities (NE)	402,804	496,051	-10,420	485,631	510,776

[a] The Office of Nuclear Energy, Science and Technology's portion of the use of prior year balances reduction from the Consolidated Appropriations Act, 2005.
[b] Distribution of the rescission from the Consolidated Appropriations Act, 2005.
[c] This amount, as well as $5.223M in Energy Supply is being transferred to the Office of Environmental Management.
[d] Amount includes comparability adjustments of $271K for the rescission in the Consolidated Appropriation Act, 2005, and $68K for A-76 financial services.

Appropriation Summary by Program

(Excludes Transfers to Other Defense Activities)

(dollars in thousands)

	FY 2004 Comparable Appropriation	FY 2005 Original Appropriation	FY 2005 Adjustments	FY 2005 Comparable Appropriation	FY 2006 Request
Energy Supply					
University Reactor Infrastructure and Education Assistance	23,055	24,000	-190[a]	23,810	24,000
Research and Development					
Nuclear Energy Plant Optimization	2,863	2,500	-20[a]	2,480	0
Nuclear Energy Research Initiative	6,410	2,500	-19[a]	2,481	0
Nuclear Power 2010	19,360	50,000	-395[a]	49,605	56,000
Generation IV Nuclear Energy Systems Initiative	26,981	40,000	-317[a]	39,683	45,000
Nuclear Hydrogen Initiative	6,201	9,000	-71[a]	8,929	20,000
Advanced Fuel Cycle Initiative	65,750	68,000	-538[a]	67,462	70,000
Total, Research and Development	127,565	172,000	-1,360	170,640	191,000
Infrastructure					
Radiological Facilities Mgmt	63,431	69,110	-547[a]	68,563	64,800
Idaho Facilities Management	54,119	92,164	-730[a]	91,434	80,100
Total, Infrastructure	117,550	161,274	-1,277	159,997	144,900
Spent Nuclear Fuel Management	0	5,223	-6,723[b]	-1,500	0
Program Direction	26,019	26,427	+89[c]	26,516	30,006
Subtotal, Energy Supply	294,189	388,924	-9,461	379,463	389,906
Less Security Charge for Reimbursable Work	-3,003	0	0	0	0
Use of Prior-Year Balances	0	-4,217[d]	0	-4,217	0

[a] Distribution of the rescission from the Consolidated Appropriations Act, 2005.

[b] Amount includes $5.223M Energy Supply and $1.5M for Other Defense Activities that are being transferred to the Office of Environmental Management.

[c] Amount includes comparability adjustments of $209K for the rescission in the Consolidated Appropriations Act, 2005, $97K for one FTE transfer to the Office of the Chief Information Officer, and $395K for 2 FTEs from the National Nuclear Security Administration.

[d] The Office of Nuclear Energy, Science and Technology's portion of the use of prior year balances reduction from the Consolidated Appropriations Act, 2005.

(dollars in thousands)

	FY 2004 Comparable Appropriation	FY 2005 Original Appropriation	FY 2005 Adjustments	FY 2005 Comparable Appropriation	FY 2006 Request
Total, Energy Supply	291,186	384,707	-9,461	375,246	389,906
Other Defense Activities					
Infrastructure					
Idaho Facilities Management	21,296	20,886	-167	20,719	17,762
Idaho Sitewide Safeguards and Security	56,343	58,103	-441	57,662	75,008
Total, Infrastructure	77,639	78,989	-608	78,381	92,770
Spent Nuclear Fuel Management	0	1,500[a]	-12	1,488[a]	0
Program Direction	33,979	33,858	-339[b]	33,519	31,103
Subtotal, Other Defense Activities	111,618	114,347	-959	113,388	123,873
Less Security Charge for Reimbursable Work	0	-3,003	0	-3,003	-3,003
Total, Other Defense Activities	111,618	111,344	-959	110,385	120,870
Total, Energy Supply and Other Defense Activities (NE)	402,804	496,051	-10,420	485,631	510,776

Preface

The Office of Nuclear Energy, Science and Technology (NE) leads the Government's efforts to develop new nuclear energy generation technologies to meet energy and climate goals, to develop advanced, proliferation-resistant nuclear fuel technologies that maximize energy from nuclear fuel, and to maintain and enhance the national nuclear technology infrastructure. NE serves the present and future energy needs of the Nation by managing the safe operation and maintenance of the DOE critical nuclear infrastructure that provides nuclear technology goods and services.

Within the Energy Supply appropriation, NE has ten programs: University Reactor Infrastructure and Education Assistance, Nuclear Energy Plant Optimization, Nuclear Energy Research Initiative, Nuclear Power 2010, Generation IV Nuclear Energy Systems Initiative, Nuclear Hydrogen Initiative, Advanced Fuel Cycle Initiative, Radiological Facilities Management, Idaho Facilities Management, and Program Direction. NE also has two programs that are partially funded within the Other Defense Activities appropriation—Idaho Facilities Management and Program Direction—and one program completely funded within the Other Defense Activities appropriation—Idaho Sitewide Safeguards and Security.

[a] This amount, as well as $5.223M in Energy Supply is being transferred to Environmental Management.
[b] Amount includes comparability adjustments of $271K for the rescission in the Consolidated Appropriations Act, 2005, and $68K for A-76 financial services.

This Overview will describe Strategic Context, Mission, Benefits, Strategic Goals and Funding by General Goal. These items together put the appropriation in perspective. The Annual Performance Results and Targets, Means and Strategies, and Validation and Verification sections address how the goals will be achieved and how performance will be measured. Finally, this Overview will also address R&D Investment Criteria, Program Assessment Rating Tool (PART), and Significant Program Shifts.

Strategic Context

Following publication of the "National Energy Policy", the Department developed a Strategic Plan that defines its mission, four strategic goals for accomplishing that mission, and seven general goals to support the strategic goals. Each appropriation has developed quantifiable goals to support the general goals. Thus, the "goal cascade" is the following:

Department Mission → Strategic Goal (25 yrs) → General Goal (10-15 yrs) → Program Goal (GPRA Unit) (10-15 yrs)

To provide a concrete link between budget, performance, and reporting, the Department developed a "GPRA[a] unit" concept. Within DOE, a GPRA unit defines a major activity or group of activities that support the core mission and aligns resources with specific goals. Each GPRA unit has completed or will complete a Program Assessment Rating Tool (PART). A unique program goal was developed for each GPRA unit. A numbering scheme has been established for tracking performance and reporting.[b]

The goal cascade accomplishes two things. First, it ties major activities for each program to successive goals and, ultimately, to DOE's mission. This helps ensure the Department focuses its resources on fulfilling its mission. Second, the cascade allows DOE to track progress against quantifiable goals and to tie resources to each goal at any level in the cascade. Thus, the cascade facilitates the integration of budget and performance information in support of the GPRA and the President's Management Agenda (PMA).

Another important component of our strategic planning – and the President's Management Agenda – is use of the Administration's R&D investment criteria to plan and assess programs and projects. The criteria were developed in 2001 and further refined with input from agencies, Congressional staff, the National Academy of Sciences, and numerous private sector and nonprofit stakeholders.

The chief elements of the R&D investment criteria are quality, relevance, and performance. Programs must demonstrate fulfillment of these elements. For example, to demonstrate relevance, programs are expected to have complete plans with clear goals and priorities. To demonstrate quality, programs are expected to commission periodic independent expert reviews. There are several other requirements, many of which R&D programs have and continue to undertake.

An additional set of criteria were established for R&D programs developing technologies that address industry issues. Some key elements of the criteria include: the ability of the programs to articulate the appropriateness and need for Federal assistance; relevance to the industry and the marketplace; identification of a transition point to industry commercialization (or of an off-ramp if progress does not

[a] Government Performance and Results Act of 1993

[b] The numbering scheme uses the following numbering convention: First two digits identify the General Goal (01 through 07); second two digits identify the GPRA Unit; last four digits are reserved for future use.

meet expectations), and; the potential public benefits, compared to alternative investments, that may accrue if the technology is successfully deployed.

The OMB-OSTP guidance memo to agencies dated June 5, 2003, describes the R&D investment criteria fully and identifies steps agencies should take to fulfill them. (The memo is available online at www.ostp.gov/html/fy05developingpriority.pdf.) Where appropriate throughout these justification materials, especially in Significant Program Shifts and Explanation of Funding Changes subheadings, specific R&D investment criteria and requirements are cited to explain the Department's allocation of resources.

Mission

The mission of the Office of Nuclear Energy, Science and Technology is to lead the DOE investment in the development and exploration of advanced nuclear science and technology. NE leads the Government's efforts to develop new nuclear energy generation technologies; to develop advanced, proliferation-resistant nuclear fuel technologies that maximize energy from nuclear fuel; and to maintain and enhance the national nuclear technology infrastructure. NE aims to serve the present and future energy needs of the Nation by managing the safe operation and maintenance of the DOE nuclear infrastructure that provides nuclear technology goods and services. NE manages research laboratories and radiological facilities and is the Lead Program Secretarial Officer for the Idaho National Laboratory.

Benefits

The benefits of nuclear power as an emissions free, reliable, and affordable source of energy are an essential element in the Nation's energy and environment future. Nuclear power has become the second most abundant source of electric energy in the U.S., and existing plants are among the most economic sources of electricity on the grid today. NE focuses on the development of advanced nuclear technologies to assure diversity in the U.S. energy supply. This budget request responds to the Energy Security goal to develop new generation capacity to fortify U.S. energy independence and security while making improvements in environmental quality. It builds on important work started over the last three years to deploy new nuclear plants in the U.S. by early in the next decade, to develop advanced, next generation nuclear technology, and to strengthen our Nation's nuclear education infrastructure.

The NE budget request supports development of new nuclear generation technologies that provide significant improvements in sustainability, economics, safety and reliability, and non-proliferation and resistance to attack. Specifically, the Nuclear Hydrogen Initiative will develop advanced technologies that can be used in tandem with next generation nuclear energy plants to generate economic, commercial quantities of hydrogen to support a sustainable, clean energy future for the U.S. The Generation IV Nuclear Energy Systems Initiative establishes a basis for expansive cooperation with our international partners to develop next generation reactor and fuel cycle systems that represent a significant leap in economic performance, safety, and proliferation resistance.

Through NE programs and initiatives, NE seeks to develop advanced, proliferation-resistant nuclear fuel technologies that maximize energy output, minimize wastes, and operate in a safe and environmentally sound manner. The Advanced Fuel Cycle Initiative develops technologies that would enable the reduction of spent nuclear fuel waste requiring geologic disposal and the recovery of spent nuclear fuel's valuable energy. Over the last five years, the U.S. has joined several countries in an international effort

to pursue advanced technologies that could treat and transmute spent nuclear fuel from nuclear power plants, while reducing overall proliferation risk.

NE plans to maintain and enhance the national nuclear infrastructure currently in place to help meet the Nation's energy, environmental, health care, and national security needs. This existing infrastructure including personnel, equipment, and facilities requires enhancements to meet the systems, fuels, and material testing requirements for advanced nuclear research such as the Generation IV Nuclear Energy Systems Initiative. Key activities include assuring that all NE facilities meet essential safety and environmental requirements and are maintained at user-ready levels. One of the essential facilities for ongoing and planned national security and energy research programs at the Idaho National Laboratory is the Advanced Test Reactor (ATR).

Strategic, General, and Program Goals

The Department's Strategic Plan identifies four strategic goals (one each for defense, energy, science, and environmental aspects of the mission) plus seven general goals that tie to the strategic goals. The Office of Nuclear Energy, Science and Technology supports the following goals:

Energy Strategic Goal: To protect our national and economic security by promoting a diverse supply of reliable, affordable, and environmentally sound energy.

General Goal 4, Energy Security: Improve energy security by developing technologies that foster a diverse supply of reliable, affordable and environmentally sound energy by providing for reliable delivery of energy, guarding against energy emergencies, exploring advanced technologies that make a fundamental improvement in our mix of energy options, and improving energy efficiency.

The programs funded by the Office of Nuclear Energy, Science and Technology have the following three Programs Goals which contribute to General Goal 4 in the "goal cascade":

Program Goal 04.14.00.00: Develop new nuclear generation technologies that foster the diversity of the domestic energy supply through public-private partnerships that are aimed in the near-term (2014) at the deployment of advanced, proliferation-resistant light water reactor and fuel cycle technologies and in the longer-term (2025) at the development and deployment of next-generation advanced reactors and fuel cycles.

Program Goal 04.17.00.00: Maintain and enhance the national nuclear infrastructure to meet the Nation's energy, environmental, medical research, space exploration and national security needs.

Program Goal 04.63.00.00: Enable, by 2015, the Nation's nuclear engineering universities to support a stable national undergraduate enrollment of approximately 1,500 to meet the Nation's need for trained nuclear scientists and engineers.

Contribution to General Goal 4

The Nuclear Power 2010 program is focused on resolving the technical, institutional, and regulatory barriers to the deployment of new nuclear power plants by 2010, consistent with the recommendations of the Nuclear Energy Research Advisory Committee (NERAC) report, "A Roadmap to Deploy New

Nuclear Power Plants in the United States by 2010." In order to support the "Nation Energy Policy" and the President's goal of reducing greenhouse gas intensity by 18 percent by 2012, the Nuclear Power 2010 program will help enable an industry decision to deploy at least one new advanced nuclear power plant in the U.S. early in the next decade.

For the longer-term future, the Department believes that new, next-generation technologies should be considered to enhance the prospects for a significant expansion in the use of nuclear energy in the United States. Engaging this area requires the kind of long-term, high-risk, high-pay-off research that only Government-sponsored research can address. As a prime example, the Department believes that the future energy picture of the United States can and should include a large role for hydrogen as a fuel for automobiles and other elements of the vast U.S. transportation infrastructure. The use of hydrogen would make it possible for this Nation to realize a primary objective of the "National Energy Policy"—to enhance the energy independence and security of the United States while making significant improvements in environmental quality. Hydrogen could someday be used to power our entire transportation system, reducing our reliance on imported oil, and dramatically reducing the harmful emissions associated with the combustion of fossil fuels.

The Department is working with industry and overseas governments to establish what may prove to be an important answer: nuclear energy-produced hydrogen. Applying advanced thermochemical processes, it may be possible to develop a new generation of nuclear energy plants to produce very large amounts of hydrogen without emitting carbon dioxide or other gases—and do so at a cost that is very competitive with imported fossil fuels. The Nuclear Hydrogen Initiative will develop new technologies to generate hydrogen on a commercial scale in an economic and environmentally benign manner. The Department's Offices of Nuclear Energy, Science and Technology; Fossil Energy; and Energy Efficiency and Renewable Energy are working in coordination to provide the technological underpinnings of the President's National Hydrogen Fuel Initiative. In the case of nuclear energy, the Department will conduct research and development into advanced thermochemical technologies which may, when used in tandem with next-generation nuclear energy systems, enable the United States to generate hydrogen at a scale and cost that would support a future, hydrogen-based economy.

Developing the next-generation nuclear systems to make hydrogen possible is one aspect of the Generation IV Nuclear Energy Systems. Through this effort, the United States will lead multi-national research and development projects to usher forth next-generation nuclear reactors and fuel cycles. This international approach allows for the development of technologies that are widely acceptable; enables the Department to access the best expertise in the world to develop complex new technologies; and allows us to leverage our scarce nuclear R&D resources. After two years of detailed analysis by over 100 of the world's top scientists and engineers, the Nuclear Energy Research Advisory Committee (NERAC), working with the Generation IV International Forum (GIF), has identified six systems in pursuit of which the international community will collaborate and conduct joint research.

The FY 2006 Budget expands research and development that could help achieve the desired goals of sustainability, economics, and proliferation resistance. Further investigation of technical and economic challenges and risks, including waste products, will help inform a decision on whether to proceed with a demonstration of the Next Generation Nuclear Plant, which would use very high temperature reactor technologies to economically produce both electricity and hydrogen gas.

As the United States considers the expansion of nuclear energy, it is clear that the Nation must optimize its approach to managing spent nuclear fuel. While the planned geologic repository at Yucca Mountain would be sufficient for all commercial spent fuel generated in the United States through 2015, the current "once-through" approach to spent fuel will require the United States to build additional repository space to assure the continued, safe management of nuclear waste from currently operating plants and a new generation of nuclear plants. Further, long-term issues associated with the toxicity of nuclear waste and the eventual proliferation risks posed by plutonium in spent fuel remain.

The Advanced Fuel Cycle Initiative (AFCI) is focused on developing technologies which can reduce the volume and long-term toxicity of high level waste from spent nuclear fuel, reduce the long-term proliferation threat posed by civilian inventories of plutonium in spent fuel, and provide for proliferation-resistant technologies to recover the energy content in spent nuclear fuel. Currently, the spent nuclear fuel at nuclear plant sites contains the energy equivalent of 6 billion barrels of oil or about two full years of U.S. oil imports. The AFCI will make it possible to establish an improved, optimized nuclear fuel cycle that will turn this waste into a huge source of energy and do so in a manner that improves the long-term proliferation-resistance of the civilian nuclear fuel cycle.

In addition to nuclear research and development programs, the Department has the responsibility to maintain and enhance the Nation's nuclear infrastructure currently in place. This includes one of the world's most comprehensive research infrastructures—most of which was constructed in the 1950s and 1960s. The Department is also responsible for providing critical support to our Nation's university nuclear engineering programs and associated research reactor infrastructure. It is imperative that we maintain and enhance our national nuclear capabilities by managing these resources and capabilities to ensure that they continue to be operational and available for the fulfillment of important national research and security missions. Guided by invaluable input from NERAC, we seek efficient ways to preserve our national nuclear assets and make appropriate investments to enhance them before passing them on to future generations.

The Radiological Facilities Management program maintains irreplaceable DOE nuclear technology facilities in a safe, secure, environmentally compliant and cost-effective manner to support national priorities. It maintains the Department's vital resources and capabilities of NE-managed facilities at Oak Ridge National Laboratory (ORNL), Los Alamos National Laboratory (LANL), Sandia National Laboratory (SNL), and Brookhaven National Laboratory (BNL). Central to this infrastructure is the Nation's nuclear technology laboratory, the multi-program Idaho National Laboratory (INL). The Department is proceeding with plans to establish the INL as the world's finest nuclear technology laboratory within 10 years. The Radiological Facilities Management program also supports the oversight and planning required to assure that the Department's nuclear fuel cycle assets—principally the Paducah Gaseous Diffusion Plant—can respond, as required, to future national requirements.

The Idaho Facilities Management program maintains the Department's facilities at Idaho in a safe, secure and environmentally compliant condition for a range of vital Federal missions. The Idaho Sitewide Safeguards and Security program supports activities that are required to protect the Department's Idaho complex assets from theft, diversion, sabotage, espionage, unauthorized access, compromise, and other hostile acts which may cause unacceptable adverse impacts on national security, program continuity, the health and safety of employees, the public, or the environment.

The University Reactor Infrastructure and Education Assistance program supports the operation and upgrade of university research and training reactors, provides graduate fellowships and undergraduate scholarships to outstanding students, uses innovative programs to bring nuclear technology education to small, minority-serving institutions, and provides nuclear engineering research grants to university faculty. The program helps to maintain domestic capabilities to conduct research and the critical infrastructure necessary to attract, educate, and train the next generation of scientists and engineers with expertise in nuclear energy technologies. The Department also partners with industry in a 50/50 cost share program to assist the universities in maintaining their research capabilities. DOE also provides the supply of fresh fuel to university research reactors and supports reactor equipment upgrades at universities.

The Program Direction account funds expenses associated with the technical direction and administrative support of NE programs. NE is responsible for leading the Federal government's investment in nuclear science and technology by investing in innovative science and preserving the national research and development infrastructure. This program supports NE's Headquarters, Idaho, and Oak Ridge offices, and the U.S. mission to the Organization for Economic Cooperation and Development. NE plans to perform its mission, goals, and activities with excellence in accordance with the President's Management Agenda by: creating an organization that will more effectively implement the Secretary's priorities; updating and expanding the independently created Office of Nuclear Energy, Science and Technology Workforce Plan; and continuing to recruit a well-qualified, diverse workforce.

Funding by General and Program Goal

(dollars in thousands)

	FY 2004	FY 2005	FY 2006
General Goal 4, Energy Security			
Program Goal 04.14.00.00, Develop new nuclear generation technologies	118,292	165,679	191,000
Program Goal 04.17.00.00, Maintain and enhance the national nuclear infrastructure	195,189	238,378	237,670
Program Goal 04.63.00.00, Enhance the Nation's nuclear education infrastructure capability	23,055	23,810	24,000
All Other	69,271	64,984	61,109
Total, General Goal 4, Energy Security	405,807	492,851	513,779

Major FY 2004 Achievements

In FY 2004, the Department issued an innovative Request for Proposals that was designed to make the Idaho National Laboratory the premier nuclear energy research laboratory in the world in ten years. The INL will play a lead role in developing Generation IV nuclear energy systems, advanced nuclear fuel cycle technologies, and space nuclear power applications. The new contract was awarded in November

2004 to Batelle Energy Alliance, LLC. Beginning in the second quarter of FY 2005, the Idaho National Engineering and Environmental Laboratory (INEEL) will be merged with Argonne National Laboratory-West (ANL-W) to establish the basis of the Idaho National Laboratory (INL). The Secretary of Energy has designated INL as the center for the Department's strategic nuclear energy research and development efforts. The INL will play a lead role in Generation IV nuclear energy systems development, advanced fuel cycle development, testing of naval reactor fuels and reactor core components, and space nuclear power applications. While the laboratory has transitioned its research and development focus to nuclear energy programs, it is also maintaining its multi-program national laboratory status to serve a variety of current and planned Department and national research and development missions.

In FY 2004, the Department issued a solicitation inviting proposals from teams led by power generation companies to initiate New Nuclear Plant Licensing Demonstration Projects to obtain an NRC license to construct and operate a new nuclear power plant. Industry response to the November 20, 2003 solicitation has been encouraging with Department receiving proposals from three consortia representing nine U.S. power generation companies and four advanced reactor technology suppliers. The nine power generation companies responding to the solicitation operate 63 of the 103 U.S. commercial nuclear power plants. Although no company has yet announced a decision to build a plant, these companies are evaluating the construction of new nuclear plants.

Program Assessment Rating Tool (PART)

The Department implemented a tool to evaluate selected programs. PART was developed by the Office of Management and Budget (OMB) to provide a standardized way to assess the effectiveness of the Federal Government's portfolio of programs. The structured framework of the PART provides a means through which programs can assess their activities differently than through traditional reviews.

The current focus is to establish outcome- and output-oriented goals, the successful completion of which will lead to benefits to the public, such as increased national security and energy security, and reduced atmospheric emissions. DOE has incorporated feedback from OMB into the FY 2006 Budget Request, and the Department will take the necessary steps to continue to improve performance.

The Infrastructure program prepared a PART focused on the Idaho Facilities Management program where a majority of the funding requirements will occur. NE has incorporated feedback from OMB during the FY 2006 assessment as well as the FY 2004-FY 2005 assessments for Nuclear Energy R&D into the FY 2006 Budget Request and has taken or will take the necessary steps to continue to improve performance.

The results of the FY 2005 review for the Research and Development programs and the FY 2006 review for the Infrastructure program are reflected in the FY 2006 Budget Request as follows:

Nuclear Power 2010 (NP 2010) received an overall score of 69 (adequate), Generation IV Nuclear Energy Systems Initiative received an overall score of 79 (moderately effective), Advanced Fuel Cycle Initiative (AFCI) received an overall score of 76 (moderately effective), and Infrastructure received an overall score of 49 (results not demonstrated). All four were assessed perfect scores for clarity of program purpose and soundness of program design. In the planning area, OMB found a need for stronger links between budget and performance data for all four. To address these findings, stronger

links between program goals and funding requests are shown in this budget submission. In the program management area, NP 2010 needs to measure and achieve cost effectiveness in program execution. In the program results area, NP 2010 needs to establish on an annual basis an independent assessment of the overall program. Generation IV lacks periodic external review. AFCI needs to better demonstrate the cost effectiveness of the program. These findings are also addressed in this budget submission. Idaho Facilities Management received a 0 score in the program results area. This is a new program and accomplishments have yet to be demonstrated. The assessment did find that the program is effectively targeted through the formal Idaho National Laboratory Ten Year Site Plan that identifies the mission-essential infrastructure and facilities, planned annual work scope, and performance measures for the laboratory.

NERAC's Subcommittee on Evaluations, formed in FY 2004, conducted independent program evaluations of NE's Generation IV Nuclear Energy Systems Initiative, Nuclear Power 2010 program, and the Advanced Fuel Cycle Initiative. The Subcommittee submitted its findings to the full NERAC in FY 2005. These findings will be incorporated into future NE budget requests.

Significant Program Shifts

- Nuclear Hydrogen Initiative. The Administration strongly supports nuclear energy as an important part of its energy portfolio. The Nuclear Hydrogen Initiative (NHI) activities are required to support the milestones identified in the "DOE Hydrogen Posture Plan" and the "Nuclear Hydrogen R&D Plan". These plans are revised periodically and provide clear performance measures upon which to base annual budget requests. Technology development work to date which has been conducted in accordance with the "Nuclear Hydrogen R&D Plan" has proved successful and justifies continued work. For example, in FY 2004, experiments were successfully completed on individual high-temperature electrolysis cells for hydrogen production. Since the results show that the hydrogen output of the cells closely matched the theoretical calculations, in FY 2005 the program is evaluating the performance of stacks of cells to achieve higher hydrogen production rates. Based on progress to date, in FY 2006 the program will proceed with the plan to test cell stacks for long-duration and transient operation, and an integrated 50kW system will be constructed for operation in FY 2007. As a result of these successes and other technical progress, the FY 2006 budget request includes an increase of $11,071,000 (+124%) to support continued development of nuclear hydrogen technologies that can be used in tandem with next generation nuclear energy systems that span a range of operating temperatures.

- Idaho Facilities Management. The overall funding for the Idaho Facilities Management program decreases from FY 2005 to FY 2006 because of a $43,453,000 one time cost associated with restructuring the Idaho National Laboratory complex and supporting site infrastructure services. This decrease is offset by an increase of $19,718,000 for maintenance and recapitalization projects to support the goal of achieving and maintaining an expenditure rate of 2-4 percent of Replacement Plant Value, a level recommended by the National Academy of Sciences, for the facilities at INL. One of the essential facilities for ongoing and planned national security and energy research programs at the Idaho National Laboratory is the Advanced Test Reactor (ATR). Replacing the ATR with a new test reactor with similar capabilities would exceed two billion dollars and likely take at least ten years to build. An independent review group of reactor experts studied the ATR and provided their perspectives on the life extension of the reactor. This review prompted several

projects, most notably an exhaustive safety basis reconstitution to assure that all safety related systems meet modern standards. This project is in progress and results to date are favorable. The recommendations of this review and other analyses will be incorporated into the INL Ten Year Site Plan (TYSP), which is the foundation for INL facilities and infrastructure strategic planning and the cornerstone of the Program's initiative to restore the INL and the other essential facilities on the site. Specifically, the TYSP includes a prioritized list of recapitalization projects that is based upon a formal prioritization methodology that preferentially targets deferred maintenance reduction, particularly for mission-essential facilities and infrastructure and provides the basis for the budget request.

- Idaho Sitewide Safeguards and Security. As a result of merging the Idaho National Engineering and Environmental Laboratory (INEEL) and the Argonne National Laboratory-West site into the Idaho National Laboratory (INL), the two existing safeguards and security programs at the Idaho site will be merged into a single program. This integration will continue in FY 2005 with additional changes anticipated to increase efficiency and contain costs for safeguards and security for the site. The Department issued a revised Design Basis Threat (DBT) in October 2004. These requirements will be implemented using a risk-informed approach to physical upgrades and by seeking efficiencies associated with combining the two contracts. The Department believes that early investment in improved positions for defending forces, more capable detection systems, and technological deterrent devices at target locations will result in cost avoidance over the lifetime of enduring facilities by reducing the number of additional protective force members needed to counter the revised threat. The FY 2006 request reflects increased funding of $17,346,000 to permit these investments.

Office of Nuclear Energy, Science and Technology
Funding by Site by Program

(dollars in thousands)

	FY 2004	FY 2005	FY 2006	$ Change	% Change
Chicago Operations Office					
Chicago Operations Office					
Idaho Facilities Management	500	500	500	+0	+0.0%
Argonne National Laboratory					
University Reactor Infrastructure and Education Assistance	110	110	110	+0	+0.0%
Generation IV Nuclear Energy Systems Initiative	2,335	2,423	2,500	+77	+3.2%
Nuclear Power 2010	90	16	0	-16	-100.0%
Nuclear Hydrogen Initiative	710	640	1,000	+360	+56.3%
Advanced Fuel Cycle Initiative	8,200	6,913	7,000	+87	+1.3%
Total, Argonne National Laboratory	11,445	10,102	10,610	+508	+5.0%
Brookhaven National Laboratory					
Generation IV Nuclear Energy Systems Initiative	250	320	320	+0	+0.0%
Nuclear Power 2010	0	60	0	-60	-100.0%
Advanced Fuel Cycle Initiative	700	556	550	-6	-1.1%
Radiological Facilities Management.	2,373	2,673	2,650	-23	-0.9%
Total, Brookhaven National Laboratory	3,323	3,609	3,520	-89	-2.5%
Total, Chicago Operations Office	15,268	14,211	14,630	+419	+2.9%
Idaho Operations Office					
Idaho Operations Office					
University Reactor Infrastructure and Education Assistance	17,571	20,203	20,393	+190	+0.9%
Generation IV Nuclear Energy Systems Initiative	4,542	9,531	14,643	+5,112	+53.6%
Nuclear Energy Research Initiative	2,726	2,274	0	-2,274	-100.0%
Nuclear Energy Plant Optimization	880	200	0	-200	-100.0%
Nuclear Hydrogen Initiative	1,007	650	4,750	+4,100	+630.8%
Nuclear Power 2010	18,936	47,727	54,000	+6,273	+13.1%

(dollars in thousands)

	FY 2004	FY 2005	FY 2006	$ Change	% Change
Advanced Fuel Cycle Initiative	5,677	6,376	8,488	+2,112	+33.1%
Program Direction	33,375	32,235	31,103	-1,132	-3.5%
Total, Idaho Operations Office	84,714	119,196	133,377	+14,181	+11.9%
Idaho National Laboratory					
University Reactor Infrastructure and Education Assistance	4,950	3,132	3,132	+0	+0.0%
Generation IV Nuclear Energy Systems Initiative	11,137	14,084	15,250	+1,166	+8.3%
Nuclear Hydrogen Initiative	1,303	2,320	7,500	+5,180	+223.3%
Nuclear Energy Plant Optimization	650	1,710	0	-1,710	-100.0%
Nuclear Energy Research Initiative	503	0	0	+0	+0.0%
Nuclear Power 2010	20	138	0	-138	-100.0%
Advanced Fuel Cycle Initiative	27,712	25,961	32,000	+6,039	+23.3%
Radiological Facilities Management	19,244	14,732	12,200	-2,532	-17.2%
Idaho Facilities Management	74,915	111,653	97,362	-14,291	-12.8%
Idaho Sitewide Safeguards and Security	56,343	57,662	75,008	+17,346	+30.1%
Total, Idaho National Laboratory	196,777	231,392	242,452	+11,060	+4.8%
University of Nevada, Las Vegas					
Nuclear Hydrogen Initiative	1,900	3,800	2,000	-1,800	-47.4%
Advanced Fuel Cycle Initiative	3,500	6,944	4,000	-2,944	-42.4%
Total, University of Nevada, Las Vegas	5,400	10,744	6,000	-4,744	-44.2%
Total, Idaho Operations Office	286,891	361,332	381,829	+20,497	+5.7%
NNSA Service Center					
NNSA Service Center					
Nuclear Power 2010	70	0	0	+0	+0.0%
Lawrence Livermore National Laboratory					
Generation IV Nuclear Energy Systems Initiative	316	410	500	+90	+22.0%
Advanced Fuel Cycle Initiative	150	175	150	-25	-14.3%
Total, Lawrence Livermore National Laboratory	466	585	650	+65	+11.1%

(dollars in thousands)

	FY 2004	FY 2005	FY 2006	$ Change	% Change
Los Alamos National Laboratory					
Generation IV Nuclear Energy Systems Initiative	367	229	250	+21	+9.2%
Nuclear Energy Research Initiative	261	0	0	+0	+0.0%
Advanced Fuel Cycle Initiative	12,105	13,300	10,000	-3,300	-24.8%
Radiological Facilities Management	15,212	16,960	16,922	-38	-0.2%
Total, Los Alamos National Laboratory	27,945	30,489	27,172	-3,317	-10.9%
Sandia National Laboratories					
Generation IV Nuclear Energy Systems Initiative	1,270	445	600	+155	+34.8%
Nuclear Hydrogen Initiative	570	210	2,500	+2,290	+1,090.5%
Nuclear Plant Optimization	200	170	0	-170	-100.0%
Nuclear Energy Research Initiative	799	0	0	+0	+0.0%
Nuclear Power 2010	125	0	0	+0	+0.0%
Advanced Fuel Cycle Initiative	1,800	1,700	1,800	+100	+5.9%
Radiological Facilities Management	1,750	1,900	2,000	+100	+5.3%
Total, Sandia National Laboratories…	6,514	4,425	6,900	+2,475	+55.9%
Total, NNSA Service Center	34,995	35,499	34,722	-777	-2.2%
Savannah River Site Office					
University Reactor Infrastructure and Education Assistance	300	300	300	+0	+0.0%
Nuclear Energy Research Initiative	331	0	0	+0	+0.0%
Nuclear Power 2010	0	50	0	-50	-100%
Nuclear Hydrogen Initiative	180	300	750	+450	+150.0%
Advanced Fuel Cycle Initiative	800	583	700	+117	+20.1%
Total, Savannah River Site Office	1,611	1,233	1,750	+517	+41.9%
Oak Ridge Operations Office					
Oak Ridge Operations Office					
Radiological Facilities Management	0	496	500	+4	+0.8%
Program Direction	1,896	1,957	2,032	+75	+3.8%
Total, Oak Ridge Operations Office	1,896	2,453	2,532	+79	+3.2%

(dollars in thousands)

	FY 2004	FY 2005	FY 2006	$ Change	% Change
Oak Ridge National Laboratory					
University Reactor Infrastructure and Education Assistance	38	25	25	+0	+0.0%
Nuclear Energy Plant Optimization	150	150	0	-150	-100.0%
Generation IV Nuclear Energy Systems Initiative	6,252	10,110	9,050	-1,060	-10.5%
Nuclear Hydrogen Initiative	245	130	500	+370	+284.6%
Nuclear Energy Research Initiative	615	0	0	+0	+0.0%
Advanced Fuel Cycle Initiative	3,380	2,391	3,500	+1,109	+46.4%
Radiological Facilities Management	24,400	31,350	30,028	-1,322	-4.2%
Total, Oak Ridge National Laboratory	35,080	44,156	43,103	-1,053	-2.4%
Pacific Northwest National Laboratory					
Nuclear Energy Plant Optimization	930	200	0	-200	-100.0%
Nuclear Energy Research Initiative	1,052	0	0	+0	+0.0%
Advanced Fuel Cycle Initiative	450	150	150	+0	+0.0%
Total, Pacific Northwest National Laboratory	2,432	350	150	-200	-57.1%
Total, Oak Ridge Operations Office	39,408	46,959	45,785	-1,174	-2.5%
Washington Headquarters					
University Reactor Infrastructure and Education Assistance	86	40	40	+0	+0.0%
Nuclear Energy Plant Optimization	53	50	0	-50	-100.0%
Nuclear Energy Research Initiative	123	207	0	-207	-100.0%
Nuclear Power 2010	119	1,614	2,000	+386	+23.9%
Generation IV Nuclear Energy Systems Initiative	512	2,131	1,887	-244	-11.5%
Nuclear Hydrogen Initiative	286	879	1,000	+121	+13.8%
Advanced Fuel Cycle Initiative	1,276	2,413	1,662	-751	-31.1%
Radiological Facilities Mgmt	452	452	500	+48	+10.6%
Program Direction	24,727	25,843	27,974	+2,131	+8.2%
Total, Washington Headquarters	27,634[a]	33,629	35,063	+1,434	+4.3%
Total, Nuclear Energy[a]	405,807	492,863	513,779	+20,916	+4.2%

[a] Includes funding identified to fund the Environmental Management liability for OVEC in FY 2004.

Site Description

Chicago Operations Office

Idaho Facilities Management
Chicago Operations Office administers a contract with BWXT Service, Inc. for continuing spent nuclear fuel and other related material storage at the BWXT Lynchburg Technology Center.

Argonne National Laboratory

Introduction
Argonne National Laboratory (ANL) is one of the Department of Energy's scientific research laboratories and was the Nation's first national laboratory, chartered in 1946. ANL, located in Illinois, is the main laboratory and occupies 1,500 acres, surrounded by a forest preserve about 25 miles southwest of the Chicago Loop.

University Reactor Infrastructure and Education Assistance
ANL administers the International Student Exchange Program (ISEP). This program provides for student exchanges between the United States and several other nations enabling nuclear engineering and science students the opportunity to work in another nation's national laboratories and increase their training opportunities. ANL also administers part of the university summer internship program.

Generation IV Nuclear Energy Systems Initiative
ANL continues to play an important role in conducting key R&D in support of the Generation IV Nuclear Energy Systems Initiative. ANL participates in system design and evaluation activities for several Generation IV systems, makes important contributions to Generation IV fuels and materials efforts, and leads or participates in joint projects with France, Korea, Canada, Euratom, and Japan. ANL is responsible for staffing the position of Generation IV National Technical Director for Design and Evaluation Methods, who coordinates the U.S. efforts on method development and validation. ANL provides one of two U.S. experts for the Generation IV International Forum (GIF) Experts Group.

Nuclear Hydrogen Initiative
ANL supports the program by conducting laboratory analyses of thermochemical hydrogen production methods, specifically the calcium-bromine (Ca-Br) cycle.

Advanced Fuel Cycle Initiative
ANL staffs the AFCI National Technical Director position for separations technology development, providing leadership over multi-laboratory research activities in aqueous and pyroprocessing spent fuel treatment. ANL also supports the AFCI program by performing reactor physics calculations, including spent fuel throughput calculations, for existing commercial light water reactors and Generation IV thermal and fast reactor concepts. ANL also has the lead for key systems analysis activities, including certain program reports to Congress and their subsequent updates.

---

[a] Funding totals exclude reduction for security charge for reimbursable work of $3.003M. In addition, FY 2005 excludes the use of prior year reduction of $4.229M.

Brookhaven National Laboratory

Introduction
The Brookhaven National Laboratory (BNL) is a multiprogram laboratory located in Upton, New York. The Department of Energy's BNL conducts research in the physical, biomedical, and environmental sciences, as well as in energy technologies. Brookhaven also builds and operates major facilities available to university, industrial, and government scientists. BNL provides expertise in the design of spallation targets and also related work in the design of the subcritical multiplier.

Generation IV Nuclear Energy Systems Initiative
BNL is conducting probabilistic risk assessment tasks in support of the Generation IV proliferation resistance studies and conducting an I-NERI project on advanced gas-cooled reactors.

Advanced Fuel Cycle Initiative
BNL supports the AFCI program in the conduct of transmutation and fuel systems analyses.

Radiological Facilities Management
The Brookhaven Linear Isotope Producer (BLIP) at BNL uses a linear accelerator that injects 200 million-electron-volt protons into the 33 giga-electron-volt Alternating Gradient Synchrotron. The BLIP facility operations have decreased from 20 weeks to 10 weeks per year. Isotopes such as strontium-82, germanium-68, copper-67, and others that are used in medical diagnostic applications are produced at BLIP.

Idaho Operations Office
The Idaho Operations Office provides procurement, contract, cooperative agreement, and grant support for the Generation IV Nuclear Energy Systems Initiative, Nuclear Energy Research Initiative, Nuclear Energy Plant Optimization, Nuclear Hydrogen Initiative, Nuclear Power 2010, and the Advanced Fuel Cycle Initiative programs.

University Reactor Infrastructure and Education Assistance
The Idaho Operations Office administers the grants for the NE & HP fellowships and scholarships and the DOE/Industry Matching Grants program, and the NE Education Opportunities program.

Idaho National Laboratory

Introduction
The Idaho National Laboratory (INL) is an extensive research and engineering complex that has been the center of nuclear energy research since 1949. It occupies 890 square miles in southeastern Idaho along the western edge of the Snake River Plain, 42 miles northwest of Idaho Falls, Idaho. There are nine primary facilities at the INL as well as administrative, engineering, and research laboratories in Idaho Falls, Idaho. The Office of Nuclear Energy, Science and Technology (NE) has assumed Lead Program Secretarial Office (LPSO) responsibility for the Idaho Operations Office (ID). With the transfer of INL from EM to NE, INL will become the center for NE's strategic nuclear energy research and development enterprise, INL's revised mission will play a major role in Generation IV nuclear energy systems development, advanced fuel cycle development, and space nuclear power and propulsion applications. The INL will transition its research and development focus from environmental programs to nuclear energy programs while maintaining its multi-program national laboratory status to best serve

ongoing and future DOE and national needs. While INL will focus on its new role as the center for nuclear research and development as a multi-program national laboratory, the INL will continue to pursue appropriate roles in national security, environmental and other activities. Beginning in the second quarter of FY 2005, ANL-West will become part of INL.

University Reactor Infrastructure and Education Assistance
INL administers the University Reactor Infrastructure and Education Assistance Program to provide fuel for university research reactors including fuel for conversions from highly enriched uranium (HEU) to low enriched uranium (LEU), and to ship spent fuel from university reactors to DOE's Savannah River Site. INL also administers the peer-review of the Nuclear Engineering Education Research (NEER) program that provides competitive investigator-initiated, research grants to nuclear engineering schools; the university reactor upgrade program that provides funding for improvements and maintenance of 20-25 university research reactors; and part of the university programs summer internship program.

Generation IV Nuclear Energy Systems Initiative
INL is the lead laboratory for the Generation IV Nuclear Energy Systems Initiative and conducts the program's technical integration activities. INL provides the R&D leadership for the Very High Temperature Reactor (VHTR) and is responsible for the system integration aspects of the Gas Fast Reactor, the Supercritical-Water Reactor, and the Lead Fast Reactor (with LLNL). INL leads or participates in system design and evaluation activities for these systems, and makes important contributions to fuel, materials and energy conversion system efforts. INL, together with ORNL, is the principal laboratory responsible for the development of advanced gas reactor fuel for the VHTR. INL leads or participates in a number of joint projects with France, Korea, Canada, Euratom, and Japan. INL is responsible for staffing the position of Technical Director of the Generation IV International Forum (GIF) Secretariat and supporting staff, and plays a key role in organizing international GIF Policy Group meetings. INL is also responsible for staffing the position of Chair of the GIF Experts Group and for the organization of the GIF Experts Group meetings. INL provides chairs or co-chairs for several GIF System Steering Committees and GIF Project Management Boards.

Nuclear Hydrogen Initiative
INL will provide leadership in executing the Nuclear Hydrogen Initiative. INL will cooperate with SNL, in its role as Generation IV National Technical Director for Energy Conversion Systems, to ensure efficient integration of Generation IV and Nuclear Hydrogen Initiative activities.

Nuclear Energy Plant Optimization
INL is conducting activities which include hot cell modifications to support post irradiation examination of commercial light water reactor fuel and related materials.

Nuclear Power 2010
INL will complete work to assess the transportation and fuel cycle impacts of advanced reactor designs in support of the Early Site Permit applications to be submitted to NRC under the Nuclear Power 2010 program.

Advanced Fuel Cycle Initiative
INL staffs the AFCI National Technical Director positions for Fuels and Systems Analysis, leading the efforts of several national laboratories in the Generation IV and transmutation fuels, systems analysis and computer modeling arenas. INL has the lead role for the design of the AFCI Uranium Extraction

Plus (UREX+) engineering scale experiment (ESE) to establish the feasibility of the advanced aqueous treatment process for conditioning spent nuclear fuel. INL is also responsible for pyroprocessing research and qualification of resulting waste forms. INL capabilities also include nuclear fuel development, irradiation of AFCI transmutation and Generation IV test fuels, post-irradiation examinations, waste and nuclear material characterization, and development of dry, interim storage for spent fuel and other highly radioactive materials.

Radiological Facilities Management
INL operates the radioisotope power systems heat source and test and assembly operations that were transferred from the Mound Site. Activities also include the transfer of neptunium-237 (Np-237) inventory from the Savannah River Site to the INL during FY 2005.

Idaho Facilities Management
NE manages the Advanced Test Reactor (ATR) and other non-reactor nuclear facilities at INL including day-to-day oversight with responsibility for safe operations; startup authority; safety basis documentation approval; accomplishment of program missions on schedule and within budget; and protection of the workers, the public, and the environment. The Idaho Test Reactor Area (TRA) is located within the INL. Since the early 1950s, test reactors, laboratories, hot cells and supporting facilities have been built at TRA. The principal facility operating at TRA is the ATR. The ATR is one of the world's largest and most advanced test reactors. It currently provides vital irradiation testing for reactor fuels and core components, primarily for the U.S. Navy Nuclear Propulsion Program. The ATR can also produce isotopes critically needed by medicine and industry.

Other facilities currently operating on the site are: the ATR Critical Facility reactor, which supports ATR operations; the TRA Hot Cells; the Office of Science's Safety and Tritium Applied Research (STAR) Facility, which does fusion fuel research and has been designated by the Secretary of Energy as a National User Facility; and the INL Applied Engineering and Development Laboratory. ATR operations and a wide variety of scientific research projects are planned to continue at TRA until well into the twenty-first century. The following facilities at TRA are shutdown in a surveillance and maintenance status awaiting decontamination and decommissioning: the Materials Test Reactor (MTR), the MTR Canal, the Engineering Test Reactor, the Coupled Fast Reactivity Measurement Facility, and the Advanced Reactivity Measurement Facility.

The INL Infrastructure account provides for maintaining and upgrading TRA common use facilities and the utility infrastructure to ensure that programmatic, reliability and ES&H requirements are met.

Activities under the Idaho Facilities Management Program involve a number of significant facilities, including the Hot Fuel Examination Facility (HFEF), Fuel Conditioning Facility (FCF), Fuel Manufacturing Facility (FMF), Analytical Laboratory (AL), Electron Microscopy Laboratory (EML), and Radioactive Scrap and Waste Facility (RSWF). These facilities are supported by several other nuclear, radiological and industrial support and office facilities.

Idaho Sitewide Safeguards and Security
The Idaho Sitewide Safeguards and Security program provides protection of nuclear materials, classified matter, government property, and other vital assets from unauthorized access, theft, diversion, sabotage, espionage, and other hostile acts that may cause risks to national security, the health and safety of DOE

and contractor employees, the public or the environment. Program activities include security systems, material control and accountability, information and cyber security, and personnel security. In addition, a protective force is maintained. These activities ensure that the site, personnel, and assets remain safe from potential threats.

University of Las Vegas, Nevada

Nuclear Hydrogen Initiative
UNLV is working with the Department to perform research and development on candidate heat exchanger designs. UNLV's scope has increased to include much of the complimentary materials development activities. UNLV actively involves other universities, industry, and national laboratories, making it an effective tool for developing the future work force and an important part of the NHI program.

Advanced Fuel Cycle Initiative
UNLV is actively engaged in experiments on lead alloy coolants and targets in accelerator-based systems with potential application to fast reactor systems. UNLV also conducts research using student participation.

Lawrence Livermore National Laboratory

Introduction
Lawrence Livermore National Laboratory (LLNL) is a multi-disciplinary research and development laboratory focused on national defense, which has two noncontiguous geographic locations in northern California. LLNL is approximately one square mile and is located 40 miles east of San Francisco. LLNL conducts research in advanced defense technologies, energy, environment, biosciences, and basic science.

Generation IV Nuclear Energy Systems Initiative
LLNL is working on the development of the Generation IV lead-cooled fast reactor and associated fuel cycle. LLNL and INL serve as the Systems Integration Manager for the lead-cooled fast reactor.

Advanced Fuel Cycle Initiative
LLNL provides expertise on the impact of separation technologies on the geological repository.

Los Alamos National Laboratory

Introduction
Los Alamos National Laboratory (LANL) is a multi-disciplinary research facility located on approximately 28,000 acres near the town of Los Alamos in northern New Mexico. LANL is engaged in a variety of programs for DOE and other government agencies. The primary mission for LANL is research and technical activities supporting the Nation's defense. LANL also supports DOE missions related to arms control, non-proliferation, nuclear material disposition, energy research, science and technology, and environmental management. Research and development in the basic sciences, mathematics, and computing have a broad range of applications, including: national security, non-nuclear defense, nuclear and non-nuclear energy, atmospheric and space research, geoscience, bioscience, biotechnology, and the environment.

Generation IV Nuclear Energy Systems Initiative
LANL is working on the development of the Generation IV lead-cooled fast reactor and associated fuel cycle. A senior LANL scientist serves as the National Technical Director for fuels research.

Advanced Fuel Cycle Initiative
LANL supports the AFCI and Generation IV programs through advanced fuels, materials and transmutation engineering research, including accelerator-driven systems. LANL staffs the AFCI National Technical Director position for Transmutation Engineering. LANL also supports activities under the transmutation science education program related to nuclear science and engineering research at U.S. universities.

Radiological Facilities Management
At LANL, a portion of the Plutonium Facility-4 at the Technical Area-55 is dedicated to Pu-238 activities. This capability is the only existing Pu-238 purification and encapsulation capability within the DOE complex and is used to process and encapsulate Pu-238 used in radioisotope power sources for the National Aeronautics and Space Administration (NASA) space exploration missions and national security applications. The LANL capabilities were expanded to include establishing a Pu-238 scrap recovery capability to recycle Pu-238 scrap for use in future missions.

At LANL, the 100 MeV Isotope Production Facility (IPF) will be operable in FY 2005 and will produce major isotopes, such as germanium-68, a calibration source for Positron Emission Tomography (PET) scanners; strontium-82, the parent of rubidium-82, used in cardiac PET imaging; and arsenic-73 used as a biomedical tracer.

Sandia National Laboratories

Introduction
Sandia National Laboratories (SNL) is a research development facility located on approximately 18,000 acres on the Kirtland Air Force Base reservation near Albuquerque, New Mexico and has smaller facilities in Livermore, California and Tonopah, Nevada. The mission of SNL is to meet national needs in the nuclear weapons and related defense systems, energy security, and environmental integrity.

Generation IV Nuclear Energy Systems Initiative
SNL is responsible for staffing the position of National Technical Director for Energy Conversion, who coordinates the U.S. R&D on advanced systems for converting nuclear-generated heat into marketable energy products. This R&D is focused on advanced gas turbo-machinery with helium or supercritical carbon dioxide as the working fluids.

Nuclear Hydrogen Initiative
SNL serves as the technical integrator for the Nuclear Hydrogen Initiative, responsible for coordinating the participation of all laboratories in the development and conduct of the Nuclear Hydrogen Initiative R&D program. SNL is conducting research and development on the sulfur-iodine thermochemical process to complete an integrated demonstration in FY 2007.

Nuclear Energy Plant Optimization
SNL has supported and conducted analysis on a security pilot demonstration project to be conducted at an existing nuclear power plant.

Advanced Fuel Cycle Initiative
SNL serves as NE's technical integrator for AFCI, responsible for coordinating the participation of all laboratories in the development and conduct of the AFCI R&D program. SNL is also an integral part of the AFCI systems analysis effort.

Radiological Facilities Management
NE manages the Annular Core Research Reactor (ACRR) and other non-reactor nuclear facilities at SNL including day-to-day oversight with responsibility for safe operations; startup authority; safety basis documentation approval; accomplishment of program missions on schedule and within budget; and protection of the workers, the public, and the environment. The ACRR is a highly flexible facility applied to the mission requirements of the Department in both isotope and national security applications. National security programs use the ACRR's short duration high-power pulse capabilities for component testing.

Savannah River Operations Office

University Reactor Infrastructure and Education Assistance
Savannah River administers the radiochemistry program.

Nuclear Hydrogen Initiative
Savannah River assists with thermochemical cycle activities.

Advanced Fuel Cycle Initiative
Savannah River assists with separations technology activities, advanced fuels development activities, and systems analysis activities.

Oak Ridge Operations Office

Radiological Facilities Management
To assess USEC Inc.'s (USEC) performance, the Oak Ridge Operations Office will establish a baseline by evaluating and assessing the status of key systems required for plant viability and conduct quarterly status review meetings with USEC. The Oak Ridge Operations Office will also monitor (via an earned value management system) the DOE contractor supporting the Paducah Gaseous Diffusion Plant Operational Assurance Program.

Oak Ridge National Laboratory

Introduction
The Oak Ridge National Laboratory (ORNL) is a U.S. Department of Energy scientific research laboratory located in Oak Ridge, Tennessee. ORNL also maintains the DOE computer code system, software, and documentation at the Radiation Safety Information Computational Center (RSICC) and serves as a repository for DOE computational research activities, including computer software that is developed by NEER research projects. The RSICC computer software is made available to nuclear engineering departments, NERI and NEER awardees.

University Reactor Infrastructure and Education Assistance
ORNL administers part of the university summer internship program.

Generation IV Nuclear Energy Systems Initiative
ORNL and INL are the principal laboratories responsible for the development of advanced gas reactor fuel for the Very High Temperature Reactor. ORNL will fabricate gas reactor fuel in a laboratory-scale facility to supply demonstration fuel for irradiation testing and fuel performance modeling. ORNL also staffs the Generation IV National Technical Director for Materials and conducts much of the materials testing in support of the Generation IV Nuclear Energy Systems Initiative.

Nuclear Hydrogen Initiative
ORNL conducts research on the potential for thermochemical process improvements using membranes, specifically those previously developed for the gaseous diffusion process.

Advanced Fuel Cycle Initiative
ORNL conducts research in basic and applied science in support of the AFCI program. ORNL provides materials expertise to develop spallation targets and specific reactor components, conducts research and development on advanced separations technologies, transmutation fuels for light water and gas-cooled reactors and participates in the development and deployment planning of advanced aqueous spent fuel treatment technologies.

Radiological Facilities Management
ORNL provides the unique capabilities for fabricating carbon insulator and iridium heat sources components for radioisotope power sources used for NASA space exploration missions. These sophisticated heat source components are necessary for the safe operation of these power systems during normal operation and during launch, reentry or other deployment accidents.

Enriched stable isotopes are processed at two new laboratories. The material laboratory performs a wide variety of metallurgical, ceramic, and high vacuum processing techniques; the chemical laboratory performs scraping, leaching, dissolving, oxidizing processes to remove unwanted materials and place the isotope into a "chemically stable" form. Radioactive isotopes are chemically processed and packaged in hot cells in Building 3047.

ORNL provides baseline operation and maintenance of Building 3019, which has 1.5 metric tons of uranium, containing 450 kilograms of U-233. ORNL will begin the construction phase of the uranium-233 project, which includes procuring and installing uranium processing equipment in Building 3019, facility modifications and removal of legacy equipment. This effort will support the uranium-233 down blending and extraction of the medical isotope thorium-229 that is scheduled to begin in FY 2009.

Pacific Northwest National Laboratory

Introduction
Pacific Northwest National Laboratory (PNNL) is a multi-program laboratory located on approximately 640 acres of the Department's Hanford site. PNNL also monitors a marine science lab in Sequim, Washington.

Nuclear Energy Plant Optimization
PNNL is contracting with AEA technologies to transfer the Mechanical Stress Improvement Process to other countries in the former Soviet Union.

Advanced Fuel Cycle Initiative
PNNL provides technical support to the AFCI in the areas of advanced separations, fuels, and systems analysis.

Washington Headquarters

Washington Headquarters includes funding for the FY 2004 reduction to fund OVEC and other small business initiatives. In FY 2005, funding for the use of prior year balances reduction, Small Business and Innovative Research (SBIR), and other small business initiatives is included in Washington Headquarters. FY 2006 includes funding for SBIR and other small business initiatives.

University Reactor Infrastructure and Education Assistance
Includes funding to Morgan State University for the continuation of the DOE/NE Nuclear Energy Bridge Program.

Nuclear Power 2010
Includes funding for activities to be conducted in support of the combined Construction and Operating License (COL) demonstration projects.

Radiological Facilities Management
Includes funding for annual NRC certification for isotope shipping casks, independent financial audits of the revolving fund, and other related expenses.

University Reactor Infrastructure and Education Assistance

Funding Profile by Subprogram

(dollars in thousands)

	FY 2004 Comparable Appropriation	FY 2005 Original Appropriation	FY 2005 Adjustments	FY 2005 Comparable Appropriation	FY 2006 Request
University Reactor Infrastructure and Education Assistance	23,055	24,000	-190	23,810	24,000

Mission

The mission of the University Reactor Infrastructure and Education Assistance program is to enhance the national nuclear education infrastructure to meet the manpower requirements of the Nation's energy, environmental, health care, and national security sectors.

Benefits

The United States has led the world in the development and application of nuclear technology for many decades. This leadership, which spans energy, national security, environmental, medical and other applications, has been possible because the United States Government has helped foster advanced nuclear technology education at many universities and colleges across the Nation. The government's role is now to help these programs to maintain the education and training infrastructure necessary to develop the next generation of nuclear scientists and engineers. During the 1980s and 1990s, the number of students entering nuclear engineering programs in the United States declined causing a corresponding decline in nuclear engineering programs and research reactors. As the decline continued, the existing expertise in the nuclear field was reaching retirement age. Thus, the demand for nuclear scientists and engineers exceeded supply. The University Reactor Infrastructure and Education Assistance program addresses these issues by providing support to university nuclear engineering programs and the university research reactor community.

Strategic and Program Goals

The Department's Strategic Plan identifies four strategic goals (one each for defense, energy, science, and environmental aspects of the mission) plus seven general goals that tie to the strategic goals. The University Reactor Infrastructure and Education Assistance program supports the following goal:

Energy Strategic Goal

General Goal 4, Energy Security: Improve energy security by developing technologies that foster a diverse supply of reliable, affordable and environmentally sound energy by providing for reliable delivery of energy, guarding against energy emergencies, exploring advanced technologies that make a fundamental improvement in our mix of energy options, and improving energy efficiency.

The University Reactor Infrastructure and Education Assistance program has one program goal which contributes to General Goal 4 in the "goal cascade":

Program Goal 04.63.00.00: Enable, by 2015, the Nation's nuclear engineering universities to support a stable national undergraduate enrollment of approximately 1,500 to meet the Nation's need for trained nuclear scientists and engineers.

Contribution to Program Goal 04.63.00.00 (Enhance the Nation's nuclear education infrastructure)

The University Reactor Infrastructure and Education Assistance program contributes to the program goal by supporting outstanding students and faculty and providing support for education and research activities in the nuclear-related fields that will benefit the Nation's universities, laboratories, private sector and government. It also provides funding to improve existing infrastructure to ensure that the vital facilities used in training and educating our nuclear workforce are effective. Annual increases in undergraduate and graduate enrollments in nuclear engineering and science curricula are monitored to ensure the effectiveness of the program goal in producing nuclear scientists and engineers to fulfill national requirements.

Annual Performance Results and Targets

FY 2001 Results	FY 2002 Results	FY 2003 Results	FY 2004 Results	FY 2005 Targets	FY 2006 Targets
Program Goal 04.63.00.00 (Energy Security) University Reactor Infrastructure and Education Assistance					*Establish the performance baseline for the management of the Innovations in Nuclear Infrastructure and Education grant initiative based on initial program evaluations of the six consortia members.*
Support U.S. universities' nuclear energy research and education capabilities by: - Providing fresh fuel to all university reactors requiring this service; - Funding at least 23 universities with research reactors for reactor upgrades and improvements; - Partnering with private companies to fund 18 or more DOE/Industry Matching Grants Program for universities; and - Continue to support Reactor Sharing enabling each of the 29 schools eligible for the program to improve the use of their reactors for teaching, training, and educating within the surrounding community. (MET GOAL)	Support U.S. universities' nuclear energy research and education capabilities by: - Providing fresh fuel to university reactors requiring this service; - Funding all of the 23 universities with research reactors that apply for reactor upgrades and improvements; - Partnering with private companies to fund 20 to 25 DOE/Industry Matching Grants for universities; - Providing funding for Reactor Sharing with the goal of enabling all of the 28 eligible schools that apply for the program to improve the use of their reactors for teaching, training, and educating; and - Award two or more Innovations in Nuclear Infrastructure and Education awards. (MET GOAL)	Protect national nuclear research assets by funding 4 regional reactor centers; providing fuel to University Research Reactors; funding 20 to 25 DOE/Industry Matching Grants, 18 equipment and instrumentation upgrades, and 37 Nuclear Engineering Education Research grants; and providing 18 fellowships and 40 scholarships. (MET GOAL)	Fund the six existing regional reactor centers; provide fuel to University Research Reactors; fund 20 to 25 DOE/Industry Matching Grants, 20 equipment and instrumentation upgrades, and 50 Nuclear Engineering Education Research grants; and provide 18 fellowships and 47 scholarships. (MET GOAL)	Issue funding to the six existing Innovations in Nuclear Infrastructure and Education consortia; provide fuel to University Research Reactors; issue funding to 20 to 25 DOE/Industry Matching Grants, 20 equipment and instrumentation upgrades, and 50 Nuclear Engineering Education Research grants; and provide 25 fellowships and 75 scholarships.	Issue funding to the six existing Innovations in Nuclear Infrastructure and Education consortia; provide fuel to University Research Reactors; award 20 grants for reactor sharing; issue funding to 20 to 26 DOE/Industry Matching Grants, 20 equipment and instrumentation upgrades, and 48 Nuclear Engineering Education Research grants; provide 30 fellowships, 67 scholarships and 6 health physics fellowships; and establish and award 3 to 5 Junior Faculty grants.

FY 2001 Results	FY 2002 Results	FY 2003 Results	FY 2004 Results	FY 2005 Targets	FY 2006 Targets
Attract outstanding U.S. students to pursue nuclear engineering degrees by: - Providing 24 fellowships; - Increasing the number of Nuclear Engineering Education Research Grants to approximately 50 existing and new grants; and - Providing scholarships to approximately 50 sophomore, junior, and senior nuclear engineering and science scholarship recipients, including the partnering of minority institutions with nuclear engineering schools to allow these students to achieve a degree in their chosen course of study and nuclear engineering. (MET GOAL)	Attract outstanding U.S. students to pursue nuclear engineering degrees by: - Providing 18 graduate student fellowships with higher stipends beginning in FY 2002; - Supporting 50 university Nuclear Engineering Education Research Grants to encourage creative and innovative research at U.S. universities; and - Providing scholarships and summer on-the-job training to approximately 40 sophomore, junior and senior nuclear engineering and science scholarship recipients. (MET GOAL)				

Means and Strategies

NE will use various means and strategies to achieve its program goals. However, various external factors may impact the ability to achieve these goals. NE also performs collaborative activities to help meet its goals.

The Department will implement the following means:

- Continue to use educational incentives, including fellowships, scholarships, research funding, faculty support and private sector funding support from our Matching Grant program to increase enrollments and graduates in nuclear engineering reversing two decades of nuclear engineering infrastructure erosion.
- Pursue, as has been done the past several years, programs that increase minority participation and support by pairing nuclear engineering schools with minority institutions enabling students from minority universities to achieve degrees in both nuclear engineering and their chosen technical field.

The Department will implement the following strategies:

- Develop a pipeline of qualified and interested students in the area of nuclear science by training and educating middle and high school science teachers through the funding of the American Nuclear Society (ANS) Workshops. In addition, the Department is developing a nuclear science and technology pilot program with the Pittsburgh Public School System which will introduce a new curriculum in nuclear science allowing educators to teach nuclear science to high school students. The Department plans to partner with the private sector and other institutions to make this educational material available across the country.
- Improve the tools available to present and future students by upgrading university reactors and enabling others to share reactor time creating a stronger infrastructure by improving reactor operations and broadening the reach of the reactor facilities to those who would not otherwise have access to such sophisticated facilities.
- Meet periodically throughout the year with stakeholder organizations such as the Nuclear Engineering Department Heads Organization (NEDHO), the University Working Group, the Test, Research and Training Reactor Management Group (TRTR), and other committees of professional organizations such as the American Nuclear Society to review program activities, discuss program issues and solicit input, advice and guidance.

Validation and Verification

- All peer-reviewed university activities grantees are required to submit annual reports to DOE outlining the progress achieved. Once annual reports are submitted, they are logged in the NE database and reviewed by the NE Program Manager for compliance with the Program's stated goal and objectives. Nuclear Engineering Education Research (NEER) annual and final reports are posted to the NEER web page at http://neer.inel.gov/. These annual reports provide an opportunity to verify and validate performance. Also, quarterly, semi-annual and annual reviews of financial reports consistent with program plans are held to ensure technical progress, cost and schedule adherence, and responsiveness to program requirements.

- Program evaluations of INIE grant activities are conducted typically twice a year in conjunction with ANS meetings. In addition, comprehensive reviews are held with each INIE consortia to go over performance and cost. Each consortia member has an opportunity to provide progress information and input into upcoming performance. In addition, INIE awardees are required to submit annual progress reports to NE. They are logged in the NE database and reviewed by the NE Program Manager for compliance with program goals.

- NE conducts annual reviews of existing fellowship and scholarship recipients prior to renewing any awards.

- All three-year radiochemistry grants are reviewed annually through site visits by the program manager.

Funding by General and Program Goal

(dollars in thousands)

	FY 2004	FY 2005	FY 2006
General Goal 4, Energy Security			
Program Goal 04.63.00.00, Enhance the Nation's nuclear education infrastructure	23,055	23,810	24,000
Total, General Goal 4 (University Reactor Infrastructure and Education Assistance)	23,055	23,810	24,000

Other Information

The University Reactor Infrastructure and Education Assistance program supports the "National Energy Policy" objective to expand nuclear energy in the United States by preserving the education and training infrastructure at universities that is needed as the United States continues its reliance on advanced nuclear technologies. This program supports the continued operation of the Nation's university research and training reactors, which play a valuable role in supporting nuclear education and training.

University nuclear engineering programs supply highly skilled nuclear scientists and engineers to industry in fields such as electricity generation, national security, environmental restoration, and medicine, and to government agencies and national laboratories. To help ensure the continued viability of these programs, the Department provides assistance to university nuclear science and engineering and related programs. Assistance includes the DOE/Industry Matching Grants program which leverages public sector funds with private sector contributions in a 50/50 cost share arrangement. The Matching Grants program permits universities to strengthen their nuclear engineering course of study in a way that best fits each institution. Approximately 35 utilities and private companies match DOE's funds. Typically 20-25 universities receive funding each year. In the past several years, industry has provided more than 50 percent of the funds. The Matching Grants program has enabled university nuclear engineering programs to provide funding to areas most in need. In addition, this program has provided the means of fostering close working partnerships with the private sector.

The Nuclear Engineering Education Research (NEER) program provides vital research funding to university nuclear technology programs, encouraging innovative research at university reactors for both faculty and students. It is a competitive, peer-reviewed grant program that provides funding to conduct innovative research in nuclear science, engineering and related areas. The grants run from one to three years and are focused in one of the nine technical areas related to nuclear engineering: reactor physics, reactor engineering, reactor materials, radiological engineering, radioactive waste management, applied radiation science, nuclear safety and risk analysis, innovative technologies for next generation reactors, space power and propulsion, radiation sources or health physics. University Administrations are less apt to support nuclear engineering departments that lack viable external research support.

Academic assistance is provided to outstanding students and faculty through the Fellowships and Scholarships, Health Physics and Radiochemistry programs. A key component to the human resource capability continues to be the quality of nuclear engineering students produced by the universities. The fellowships and scholarships program helps assure outstanding students are attracted to university nuclear engineering undergraduate and graduate degree programs. The Department provides tuition, stipends, and a practicum to outstanding graduate students studying nuclear engineering and health physics and scholarships and a practicum to undergraduate students pursuing a nuclear engineering course of study. These scholarships and fellowships contribute to providing the necessary supply of trained nuclear scientists and engineers. This highly competitive program has produced outstanding graduates who have become leaders in nuclear research and university education. Also, within the fellowships and scholarships program is the University Partnership program, which encourages students, enrolled at minority-serving institutions to pursue a nuclear engineering degree at universities with nuclear engineering programs. There are currently six university partnerships consisting of 13 institutions working cooperatively in this innovative program. South Carolina State University (SCSU) and the University of Wisconsin were involved in the pilot program and now SCSU administers the program for all university partnership members. SCSU has also added two nuclear engineering faculty members and has become the only historically black college or university (HBCU) in the United States with an accredited nuclear engineering program.

One educational area that has been overlooked in the past has been Health Physics. While several of the fellowships awarded each year have been provided to students pursuing a degree in Health Physics, funds for Health Physics fellowships and scholarships have not been specifically designated in the budget. The Department formally established a Health Physics fellowships and scholarships program in FY 2005 to help increase enrollments in Health Physics to begin to address the shortage of these specialty trained personnel. This program will help heighten the visibility of Health Physics as a viable career opportunity and strengthen the Health Physics pipeline to replace retiring professionals.

The Department also provides grants every three years to support faculty and graduate/post doctorate students in radiochemistry. This program is linked to several national priorities including medicine, energy, and national defense and has been well leveraged since its inception with recipient universities supplementing the federal assistance. The once dormant radiochemistry educational apparatus has been re-energized by this program producing additional faculty and attracting new students to the discipline. Within the Radiochemistry program, the Department will establish the "Nuclear Engineering Junior Faculty Research Grants Initiative" in FY 2006. This grant initiative will assist universities in recruiting and retaining new faculty in nuclear science and engineering. The Junior Faculty Research Grants

Initiative will be a peer-reviewed grants program aimed at increasing the number of junior faculty members conducting nuclear research, which in turn will increase the level of nuclear research performed. This initiative will benefit the nuclear engineering programs by demonstrating to university administrators that viable research opportunities are available to entry-level faculty.

The Innovations in Nuclear Infrastructure and Education (INIE) program, established in FY 2002 in response to a Nuclear Energy Research Advisory Committee (NERAC) Task Force recommendation, encourages universities to make new investments in their research reactor and nuclear engineering programs while establishing strategic partnerships with other universities, national laboratories and industry. Today, the Department funds six INIE consortia, providing support to 33 universities in 23 states across the Nation. The Department's investment in this program has spurred the universities to increase their financial support for nuclear education and reactor infrastructure. The consortia ignited strategic partnerships between universities, national laboratories, and industry. These partnerships have resulted in increased use of the university nuclear reactor research and training facilities, upgrading of facilities, increased support for students, and additional research opportunities for students, faculty and other interested researchers.

To complement INIE and the other university assistance programs, the University Reactor Infrastructure and Education Assistance program provides for the fabrication and shipment of fresh fuel to university research reactors. There are currently 27 operating university research reactors at 26 institutions in the United States. These research reactors are unique and irreplaceable assets for technical education, and are used for a variety of research, educational and training purposes.

The Reactor Upgrade program provides assistance to universities to improve the operational and experimental capabilities of their research reactors. Grants are provided to universities to purchase equipment and services necessary to upgrade the reactor facilities, such as reactor instrumentation and control equipment, data recording devices, radiation, security and air monitoring equipment, and gamma spectroscopy hardware and software. Each year, approximately 20-25 universities request and receive this assistance. This program has improved the operations, safety and security of the Nation's university research reactors. The Reactor Sharing program enables universities with reactors to "share" access to their facilities with students and faculty at their own institutions, with universities that lack such a facility, and with visiting students from other local institutions including high schools and middle schools. The reactors are made available for use in research, experiments, material irradiations, neutron activation analysis and training, and for facility tours and other educational activities. Reactor Sharing is an important component of nuclear outreach providing tens of thousands of students and others the opportunity to learn about the operation of a nuclear reactor.

The Nuclear Engineering Education Support program prepares students for nuclear engineering and science careers and assists universities with special needs to improve their educational infrastructure. This program is helping to address the knowledge gap of incoming college freshmen in the area of nuclear science and engineering. In FY 2005 a nuclear science and technology education pilot was established between the Department and the Pittsburgh Public School System to provide advanced placement high school students an intensive educational experience in the field of nuclear science and technology. This effort provides course materials, tours to nuclear facilities, and lectures from internationally-recognized experts. In FY 2006, the program will apply the model used in the Pittsburgh pilot to other programs across the country, thereby strengthening the understanding of nuclear science in

our public schools.

To ensure the Department's programs are aligned with the needs of the university community and the Nation, several studies have been completed to ascertain the current status and future outlook for nuclear engineering education in the U.S. and recommend initiatives to strengthen this vital sector of the university education curriculum. The Organization for Economic Cooperation and Development Nuclear Energy Agency conducted a review of nuclear engineering education in its member countries, "Nuclear Education and Training: Cause for Concern." Similarly, the Nuclear Energy Department Heads Organization (NEDHO) surveyed U.S. industry and universities concerning manpower requirements (see www.engin.umich.edu/~nuclear/NEDHO/). The conclusion of both studies was that the enrollment trends of the 1990s were not encouraging and that more students will need to be educated in nuclear engineering to provide the trained nuclear scientists and engineers required in the future. A third study by an expert panel appointed by NERAC in 1999 recommended programmatic and funding improvements to support the nuclear engineering infrastructure in the United States. (This and related studies can be found at www.nuclear.gov.) Since then, NE funding for these efforts has doubled.

Recent surveys conducted by NEDHO and the Department have found that the increased federal support of university nuclear engineering activities has resulted in significant increases in undergraduate nuclear engineering enrollments and increased support by universities to their nuclear engineering programs and research reactors. Federal funding remains a catalyst for ensuring a viable education and training infrastructure for tomorrow's nuclear scientists and engineers.

Funding Schedule by Activity

(dollars in thousands)

	FY 2004	FY 2005	FY 2006	$ Change	% Change
University Reactor Infrastructure and Education Assistance					
University Nuclear Infrastructure	15,355	15,010	14,100	-910	-6.1%
DOE/Industry Matching Grants Program	800	1,000	1,000	0	+0.0%
Fellowships/Scholarships to Nuclear Science and Engineering Programs at Universities	1,200	2,000	2,350	+350	+17.5%
Health Physics Fellowships & Scholarships	0	200	300	+100	+50.0%
Nuclear Engineering Education Research (NEER) Grants	5,000	4,900	5,000	+100	+2.0%
Nuclear Engineering Education Opportunities	400	400	600	+200	+50.0%
Radiochemistry Awards	300	300	650	+350	+116.6%
Total, University Reactor Infrastructure and Education Assistance	23,055	23,810	24,000	+190	+0.7%

Detailed Program Justification

(dollars in thousands)

	FY 2004	FY 2005	FY 2006
University Nuclear Infrastructure (UNI)	**15,355**	**15,010**	**14,100**

The UNI program provides fuel for the universities; instrumentation, electronics, hardware, and software upgrades for the research reactors; and reactor sharing and research support for educational institutions to facilitate the development of the Nation's next generation of nuclear scientists and engineers. A continued emphasis on research infrastructure support is needed to continue the successes made to date in the Nation's university nuclear engineering programs. In FY 2004, the program provided fuel elements for the reactors at the Massachusetts Institute of Technology, Kansas State University, and the University of Missouri, California (Davis-McClellan), Penn State and Utah. In FY 2005, the program will provide fuel elements for the reactors at the Massachusetts Institute of Technology, the Universities of Missouri, Texas A&M, and California (Davis-McClellan). In FY 2006, the program will continue to provide fuel elements for these universities.

In FY 2004, the program awarded 21 grants permitting universities without research reactors to have access to reactors for training, education, and research purposes. In FY 2005 and FY 2006, the number of reactor sharing grants is expected to remain relatively constant.

In FY 2004, the program supported 20 universities to address maintenance and upgrades to equipment required at university research reactors; provided new equipment to replace antiquated equipment; maintained reactor systems; and upgraded experimental capabilities. In FY 2005 and FY 2006, the number of reactor upgrades is expected to remain constant.

In FY 2004, the Innovations in Nuclear Infrastructure and Education (INIE) grant initiative encompassed 33 universities aligned in six INIE consortia; this structure will remain intact for FY 2005. The INIE grants assist universities in continuing the integration of academics and reactor research, which enhances the quality of student education, and encourages universities to better work with the Department's national laboratories, private industry and other universities. Promoting this collaborative effort expands the use of university facilities for research, education, and training of nuclear engineers and scientists by establishing regional research and training centers and strategic partnerships. In FY 2006, the INIE program will continue these activities.

DOE/Industry Matching Grants Program.....	**800**	**1,000**	**1,000**

In FY 2004, the DOE/Industry Matching Grants program awarded grants to 26 universities for education, training, and innovative research. This program provides grants up to $60,000 that are matched by industry. In FY 2005 and FY 2006, an expected 20-26 universities will receive awards.

(dollars in thousands)

	FY 2004	FY 2005	FY 2006
Fellowships/Scholarships to Nuclear Science and Engineering Programs at Universities	**1,200**	**2,000**	**2,350**

In FY 2004, a total of 21 fellowships and 54 scholarships were awarded to students enrolled in nuclear science and engineering at U.S. universities. Fellowships are provided to M.S. and PhD. students and scholarships to undergraduate students. The fellowship and scholarship program has had many more qualified applicants than could be funded, challenging some students to continue in the field of nuclear engineering. In FY 2005, approximately 25 fellowships and 75 scholarships are expected to be awarded. In FY 2006, approximately 30 fellowships and 67 scholarships are expected to be awarded.

The University Partnership program encourages students enrolled in minority-serving institutions to pursue a nuclear engineering degree in cooperation with universities that grant those degrees. In FY 2004, the Department funded five university partnerships and expects to establish two additional partnerships in FY 2005 and one additional in FY 2006 for a total of eight.

Health Physics Fellowships & Scholarships	**0**	**200**	**300**

In FY 2005 and FY 2006, a combination of research grants**,** fellowships and scholarships will be provided to graduate and undergraduate students enrolled in Health Physics programs at U.S. universities**.** Fellowships will be provided to M.S. and PhD. students and scholarships to undergraduate students. Health physicists are responsible for ensuring the safety of workers, the general public, and the environment against the potentially harmful effects of radiation, while allowing for its beneficial uses in power production, industry, and medicine. The current demand for Health Physics professionals outstrips the supply by a factor of approximately 1:6.

Nuclear Engineering Education Research (NEER) Grants	**5,000**	**4,900**	**5,000**

In FY 2004, existing and new NEER grants totaled 51. New and existing NEER grants planned are 50 for FY 2005 and 48 for FY 2006. The NEER program provides grants allowing nuclear engineering faculty and students to conduct innovative research in nuclear engineering and related areas.

Nuclear Engineering Education Opportunities	**400**	**400**	**600**

The teacher workshops program is conducted in conjunction with the American Nuclear Society (ANS) which uses qualified volunteers from its membership to train teachers and students, keeping costs down. In FY 2004, the teacher workshops reached over five hundred teachers enabling them to teach nuclear science and engineering principles to their students. The workshops planned for FY 2005 and FY 2006 will reach thousands of teachers enabling them to teach nuclear science and engineering principles to their students. In addition, in FY 2005, the Department will introduce a new curriculum in nuclear science and technology in a national pilot program. The new program will be tested as part of the Pittsburgh Public Schools' Advanced Placement physics course.

In FY 2006, the Department will provide additional support to relevant pre-college education efforts; providing interested students and teachers with educational information about nuclear technology through development of workshops, visuals aids and other materials.

(dollars in thousands)

	FY 2004	FY 2005	FY 2006
Radiochemistry Awards	**300**	**300**	**650**

The three-year radiochemistry awards provide faculty support and student fellowships to help educate a new generation of radiochemists to address the technical challenges associated with radioactive wastes and contaminated sites. In FY 2004, the program continued to fund the existing three grants at three universities offering faculty and graduate student support. In FY 2005, the program will award three new grants. In FY 2006, the Department will establish the NE Junior Faculty Research Grants Initiative. This grants initiative will be a peer-reviewed grants program aimed at increasing the number of junior faculty members conducting nuclear research. The program will also continue to fund the existing three grants and begin to award three to five additional research grants for young faculty researchers at U.S. universities.

Total, University Reactor Infrastructure and Education Assistance	**23,055**	**23,810**	**24,000**

Explanation of Funding Changes

	FY 2006 vs. FY 2005 ($000)
University Nuclear Infrastructure (UNI)	
The decrease of $910,000 reflects a reduction of the reactor fuel program fresh fuel requirements and spent fuel shipments	-910
Fellowships/Scholarships to Nuclear Science and Engineering Programs at Universities	
The increase of $350,000 will allow for additional fellowships/scholarships to students enrolled in nuclear science and engineering at U.S. universities. Also, funds will support an additional university partnership with minority institutions to attract more minority students into the nuclear field	+350
Health Physics Fellowships & Scholarships	
The increase of $100,000 will allow for two additional fellowships to health physics students	+100
Nuclear Engineering Education Research (NEER) Grants	
The increase of $100,000 in NEER is to maintain the research efforts in the program	+100
Nuclear Engineering Education Opportunities	
The increase of $200,000 to the Nuclear Engineering Support and Education program will continue the outreach activities to more middle schools and begin activities assisting pre-college teachers and students	+200

Radiochemistry Awards

The increase of $350,000 in the Radiochemistry program will establish an NE Junior Faculty Research Grants Initiative and award three to five research grants for faculty	+350
Total Funding Change, University Reactor Infrastructure and Education Assistance	**+190**

Research and Development
Funding Profile by Subprogram

(dollars in thousands)

	FY 2004 Comparable Appropriation	FY 2005 Original Appropriation	FY 2005 Adjustments	FY 2005 Comparable Appropriation	FY 2006 Request
Research and Development					
Nuclear Energy Plant Optimization	2,863	2,500	-20	2,480	0
Nuclear Energy Research Initiative	6,410	2,500	-19	2,481	0
Nuclear Power 2010	19,360	50,000	-395	49,605	56,000
Generation IV Nuclear Energy Systems Initiative	26,981	40,000	-317	39,683	45,000
Nuclear Hydrogen Initiative	6,201	9,000	-71	8,929	20,000
Advanced Fuel Cycle Initiative	65,750	68,000	-538	67,462	70,000
Total, Research and Development	127,565[a]	172,000	-1,360	170,640	191,000

Mission

The mission of the Research and Development program is to secure nuclear energy as a viable, long-term commercial energy option to provide diversity in the energy supply. In the short-term, governmental and institutional barriers will be addressed to enable new plant deployment decisions by nuclear power plant owners and operators who wish to be among the first to license and build new nuclear facilities in the United States. In the longer-term, new nuclear technologies will be developed that can compete with advanced fossil and renewable technologies, enabling power providers to select from a diverse group of generation options that are economical, reliable, safe, secure, and environmentally acceptable.

Benefits

The benefits of nuclear science and technology to our society are numerous and increasingly important to the Nation's future. Nuclear energy presents some of our most promising solutions to the world's long-term energy challenges. Nuclear energy has the potential to generate electricity to drive our 21st century economy, to produce vast quantities of economical hydrogen for transportation use without emitting greenhouse gases, and to produce heat and clean water to support growing industry and populations all over the world. At the same time, nuclear energy presents challenges that must be met—

[a] Includes $1.83M identified as use of prior year balances to fund the Environmental Management liability for OVEC in FY 2004.

some through excellence in its use, but many others such as nuclear waste and economics—through advances in technology. Fully realizing nuclear energy's potential requires investment in long-term research to address the issues hindering its worldwide expansion. Much of the research at issue is far beyond the province of private industry given its long-term, high-risk nature; thus, the role of government in establishing a long-term future for nuclear power is clear.

Strategic and Program Goals

The Department's Strategic Plan identifies four strategic goals (one each for defense, energy, science, and environmental aspects of the mission) plus seven general goals that tie to the strategic goals. The Nuclear Energy Research and Development program supports the following goal:

Energy Strategic Goal
General Goal 4, Energy Security: Improve energy security by developing technologies that foster a diverse supply of reliable, affordable and environmentally sound energy by providing for reliable delivery of energy, guarding against energy emergencies, exploring advanced technologies that make a fundamental improvement in our mix of energy options, and improving energy efficiency.

The Nuclear Energy Research and Development program has a program goal that contributes to General Goal 4 in the "goal cascade":

Program Goal 04.14.00.00: Develop new nuclear generation technologies that foster the diversity of the domestic energy supply through public-private partnerships that are aimed in the near-term (2014) at the deployment of advanced, proliferation-resistant light water reactor and fuel cycle technologies and in the longer-term (2025) at the development and deployment of next-generation advanced reactors and fuel cycles.

Contribution to Program Goal 04.14.00.00 (Develop new nuclear generation technologies)

The Nuclear Power 2010 program supports intermediate-term research, technology development and demonstration activities that advance the "National Energy Policy" (NEP) goals of enhancing long-term U.S. energy independence and reliability and expanding the contribution of nuclear power to the Nation's energy portfolio. The Nuclear Power 2010 program supports this goal by identifying sites for new nuclear power plants, developing and bringing to market advanced standardized nuclear plant designs, evaluating the business case for building new nuclear power plants, and demonstrating untested regulatory processes leading to an industry decision in the next few years to seek Nuclear Regulatory Commission approval for building and operating at least one new advanced light water reactor plant in the United States.

The Generation IV Nuclear Energy Systems Initiative supports this goal through the development of innovative, next-generation reactor and fuel cycle technologies. The FY 2006 Budget expands research and development that could help achieve the desired goals of sustainability, economics, and proliferation resistance. Further investigation of technical and economic challenges and risks, including waste products, will help inform a decision on whether to proceed with a demonstration of the Next Generation Nuclear Plant, which would use very high temperature reactor technologies to economically produce both electricity and hydrogen gas. The Generation IV program will also invest in the

development of next-generation fast neutron spectrum reactor technologies that hold significant promise for advancing sustainability goals and reducing nuclear waste generation.

The Nuclear Hydrogen Initiative contributes to this program goal by researching, developing and demonstrating economical hydrogen production technologies using high temperature heat from advanced nuclear energy systems. The initiative will develop hydrogen production technologies that are compatible with nuclear energy systems through scaled demonstrations.

The Advanced Fuel Cycle Initiative supports this goal by developing enabling technologies to reduce spent fuel volume, separate long-lived, highly radiotoxic elements, and reclaim spent fuel's valuable energy.

Annual Performance Results and Targets

FY 2001 Results	FY 2002 Results	FY 2003 Results	FY 2004 Results	FY 2005 Targets	FY 2006 Targets
Program Goal 04.14.00.00 (Energy Security)					
Nuclear Energy Research and Development					
				Achieve cumulative variance of less than 10 percent from each of the cost and schedule baselines for the Advanced Fuel Cycle, Generation IV Nuclear Energy Systems and Nuclear Hydrogen Initiatives.	*Achieve cumulative variance of less than 10 percent from each of the cost and schedule baselines for the Advanced Fuel Cycle, Generation IV Nuclear Energy Systems and Nuclear Hydrogen Initiatives.*
Nuclear Power 2010					
	Complete and issue the government/industry roadmap to build new nuclear plants in the United States by 2010. (MET GOAL)	Under the cooperative agreements with U.S. power generation companies, support the preparation and submittal of at least two Early Site Permit applications for commercial sites to NRC. (MET GOAL)	Select for award at least one cost-shared project with a power generating company-led team for activities required to demonstrate for the first time the combined Construction and Operating License (COL) process. (MET GOAL)	Issue project implementation plans for two Construction and Operating Licensing (COL) Demonstration Projects.	Obtain the Early Site Permit (ESP) for at least one commercial site.
					Issue a Nuclear Regulatory Commission-reviewed guidance document for preparation of Construction and Operating License applications.
	Complete at least two cooperative agreements with U.S. power generating companies to jointly proceed with at least two Nuclear Regulatory Commission (NRC) Early Site Permit applications for specific DOE and/or commercial sites. (MET GOAL)	Following a competitive process, award at least one industry cost-shared cooperative agreement for technology development and regulatory demonstration activities. (NOT MET) [Procurement activities were delayed into FY 2004 pending outcome of the Energy legislation under consideration in Congress. Target was achieved in FY 2004.]			
Generation IV Nuclear Energy Systems Initiative					

FY 2001 Results	FY 2002 Results	FY 2003 Results	FY 2004 Results	FY 2005 Targets	FY 2006 Targets
Program Goal 04.14.00.00 (Energy Security)					
Formally establish the Generation IV International Forum to assist in identifying and conducting cooperative R&D. Initiate development of a Generation IV Technology Roadmap for development of next generation nuclear energy systems. (MET GOAL)	Complete the draft Generation IV Technology Roadmap for development of the next generation nuclear energy systems. (MET GOAL)	Issue the Generation IV Technology Roadmap to develop the most promising next generation nuclear energy system concepts. (MET GOAL)			
		Develop preliminary functional requirements for the Generation IV Very-High-Temperature Reactor. (MET GOAL)	Award one or more contracts for the Next Generation Nuclear Plant (NGNP) pre-conceptual design. (NOT MET) [However, DOE engaged the industry and the public in an open process to inform its development of an acquisition strategy for the NGNP. By the end of the fiscal year, the Office of Nuclear Energy, Science and Technology finalized both the Mission Need Statement and the Draft Program Announcement for the NGNP.]	Issue the final design documents for the fuel capsule, test train, fission product monitoring system, and control system for the fuel irradiation shakedown test (AGR-1).	Complete assembly of the Advanced Gas Reactor 1 (AGR-1) fuel irradiation experiment and initiate irradiation in the Advanced Test Reactor (ATR) for Very High Temperature Reactor (VHTR) fuels.
					Issue an integrated Research and Development Plan for selected Generation IV technologies.
Nuclear Hydrogen Initiative					
			Complete final designs for the baseline thermochemical and high-temperature electrolysis laboratory-scale experiments. (MET GOAL)	Issue conceptual design documents for the thermochemical and high-temperature electrolysis pilot scale experiments.	Complete construction of process hardware for the baseline thermochemical process required for integrated laboratory-scale operation in FY 2007.
Advanced Fuel Cycle Initiative					
Establish new international agreement on advanced			*Achieve variance of less than 10 percent from cost and schedule*		

FY 2001 Results	FY 2002 Results	FY 2003 Results	FY 2004 Results	FY 2005 Targets	FY 2006 Targets
Program Goal 04.14.00.00 (Energy Security)					
accelerator applications programs with at least one country that significantly leverages financial and technical resources, to the mutual benefit of both countries particularly in areas such as safety, fuels and materials development, and facility operations. (MET GOAL)			*baselines for Advanced Fuel Cycle Initiative (AFCI) activities. (MET GOAL)*		
	Successfully manufacture advanced transmutation non-fertile fuels and testing containers for irradiation testing in the Advanced Test Reactor. (MET GOAL)	Complete fabrication of test articles containing proliferation resistant transmutation fuels for irradiation in the ATR beginning in FY 2004. (MET GOAL)	Complete fabrication and irradiation of advanced light water reactor (LWR) proliferation-resistant transmutation fuel samples, and initiate post-irradiation examination of the samples. (MET GOAL)	Issue preliminary report on the post-irradiation examination (PIE) of actinide-bearing metal and nitride transmutation fuels irradiated in the Advanced Test Reactor.	Issue the reports on the post-irradiation examination and analysis of light-water reactor transmutation irradiation test articles intended to demonstrate the integrity of at least one oxide fuel form containing 5 percent plutonium and neptunium, and actinide-bearing metal and nitride transmutation fuels.
	Demonstrate separation of uranium from spent nuclear fuel at a level of 99.9 percent using the Uranium Extraction (UREX) process to support the development of advanced fuel cycles for enhanced repository performance. (MET GOAL)	Demonstrate a laboratory scale extraction of plutonium/neptunium as well as cesium/strontium from other actinides and fission products to support the development of advanced fuel cycles for enhanced repository performance. (MET GOAL)	Issue the report on the demonstration of a laboratory-scale separation of americium/curium from spent nuclear fuel to support the development of advanced fuel cycles for enhanced repository performance. (MET GOAL)	Conduct laboratory-scale test of group actinide separation process (plutonium, neptunium, americium and curium extracted together) with actual light water reactor (LWR) spent fuel and report preliminary results.	
Establish a new Advanced Accelerator Applications university fellowship program and fund 10 new graduate students in engineering and science. (MET GOAL)					

Means and Strategies

NE is using various means and strategies to achieve its program goals. However, various external factors may impact the ability to achieve these goals. Collaborative activities with other organizations and countries contribute to achieving NE's goals.

The Department is using the following means to achieve its program goals:

- A joint government/industry cost-shared effort to identify sites for new nuclear power plants, develop advanced standardized nuclear plant designs, evaluate the business case for building new nuclear power plants, and demonstrate untested regulatory processes leading to an industry decision in the next few years to seek the Nuclear Regulatory Commission's approval to build and operate at least one new advanced nuclear power plant in the United States.

- Hydrogen production technologies compatible with nuclear energy systems are being developed by the Nuclear Hydrogen Initiative. This program includes participation of the Nation's laboratories, industry, and university research communities as well as international research partners. While these technologies are not sufficiently mature to require industry cost sharing at this time, cost sharing will be required for the final engineering-scale demonstration. The initiative will employ competitive selection processes for design, construction, and operation activities.

- Advanced, next-generation reactor systems that offer the most sustainable, cost-competitive, reliable, and secure means of generating electricity and hydrogen are being developed by the Generation IV Nuclear Energy Systems Initiative. The program includes participation by the Nation's laboratories, industry, and university research communities as well as the international research community represented by the Generation IV International Forum. Industrial and international cost sharing will be pursued where practical during the research and development on these intermediate- and long-term reactor technologies.

- Research and development on advanced, proliferation-resistant fuels and fuel cycle technologies that will be used by the Generation IV reactor concepts are being developed by the Advanced Fuel Cycle Initiative. In addition, these fuels and fuel cycle technologies aim to maximize the extraction of useful energy from spent nuclear fuel and reduce civilian plutonium inventories in existing light water reactors and future light water reactors and gas-cooled reactors. The program includes participation by the Nation's laboratories, industry, and university research communities as well as the international research community. Industrial and international cost sharing will be pursued where practical during the research and development on these intermediate- and long-term fuel cycle technologies.

The Department is deploying the following strategies:

- Partnering with the private sector, national laboratories, universities, and international partners to develop advanced nuclear technologies to increase the use of nuclear energy in the United States.

- Leading the international community in pursuit of advanced nuclear technology that will benefit the United States with enhanced safety, improved economics, and reduced production of wastes.

- Integrating the NERI and I-NERI research project methodologies into its mainline nuclear R&D programs—Generation IV Nuclear Energy Systems Initiative, Advanced Fuel Cycle Initiative, and Nuclear Hydrogen Initiative.

- Conducting international cost-shared R&D in the Generation IV Nuclear Energy Systems Initiative, Advanced Fuel Cycle Initiative, and Nuclear Hydrogen Initiative.

The following external factors could affect NE's ability to achieve its strategic goal:

- Whether new nuclear plant technology is deployed depends to a large extent on power demand and economic and environmental factors beyond the scope of DOE research and development programs. In the near-term, it depends on complex economic decisions made by industrial partners.

- Approval of VHTR high temperature materials by government regulators and by national codes and standards committees introduces risk to the overall project schedule.

- Deployment of advanced fuel cycle technologies will depend upon policy towards implementation of advanced spent fuel reprocessing technologies.

- All nuclear energy research programs rely heavily on data produced through collaborations with foreign nations. Should vital data from foreign partners prove unavailable, an increased U.S. effort in technology development would be required.

In carrying out the program's mission, NE performs the following collaborative activities:

- The Department and the Nuclear Regulatory Commission (NRC) coordinate program planning to assure that their research and development activities are complimentary, cost-effective, and without duplication.

- The Department is working with industry on a cost-shared basis to conduct demonstrations of untested Federal regulatory and licensing processes governing the siting, construction, and operation of nuclear power plants.

- The Generation IV Nuclear Energy Systems Initiative is receiving broad international cooperation and support, consistent with the objectives of the program. The Generation IV International Forum (GIF), composed of representatives from ten governments and the European Union, provides guidance for executing the research and development of these next-generation nuclear energy systems.

- Participation in international experiments related to the development of advanced fuel cycle technologies is being performed in support of the objectives of the Advanced Fuel Cycle Initiative.

- NE collaborates with other programs within the Department, such as the Office of Science and the Office of Energy Efficiency and Renewable Energy, on the hydrogen fuel initiative.

Validation and Verification

To validate and verify program performance, the Office of Nuclear Energy, Science and Technology (NE) conducts various internal and external reviews and audits. NE's programmatic activities are subject to continuing review by the Congress, the General Accountability Office, the Department's Inspector General, the Nuclear Regulatory Commission, the U.S. Environmental Protection Agency, state environmental and health agencies, the Defense Nuclear Facilities Safety Board, and the Department's Office of Engineering and Construction Management. In addition, NE provides continual management and oversight of its research and development programs—the Nuclear Power 2010 program, the Generation IV Nuclear Energy Systems Initiative, the Nuclear Hydrogen Initiative, and the Advanced Fuel Cycle Initiative (AFCI). Periodic internal and external program reviews evaluate progress against established plans. These reviews provide an opportunity to verify and validate performance. Monthly, quarterly, semi-annual and annual reviews, consistent with program management plans and project baselines, are held to ensure technical progress, cost and schedule adherence, and responsiveness to program requirements.

Special reviews, including peer reviews, are also conducted by NE as appropriate. In FY 2003 and FY 2004, comprehensive NERI project reviews were held with all active NERI principal investigators together in a single forum to provide an evaluation of the significance and technical validity of research and development projects in progress. Each principal investigator served as both the presenter of their project and as a reviewer of the other projects in their technical field. These peer reviews provided an evaluation of each NERI project's continued technical merit, its progress in accomplishing stated objectives, and its programmatic contribution.

The Department obtains advice on the direction of nuclear energy R&D programs from the independent Nuclear Energy Research Advisory Committee (NERAC). NERAC, a formal Federal advisory committee, provides expert advice on long-range plans, priorities, and strategies for the nuclear technology R&D and research infrastructure activities of the Office of Nuclear Energy, Science and Technology (NE). NERAC has several active subcommittees examining various aspects of nuclear technology R&D. Reports issued by these subcommittees that address the future of nuclear energy include: the "Long-Term Nuclear Technology Research and Development Plan", the "Nuclear Science and Technology Infrastructure Roadmap", "A Roadmap to Deploy New Nuclear Power Plants in the United States by 2010", and "A Technology Roadmap for Generation IV Nuclear Energy Systems". In FY 2005, NERAC issued the "Report of the Subcommittee on Nuclear Laboratory Requirements" and "An Evaluation of the Proliferation Resistant Characteristics of Light Water Reactor Fuel with the Potential for Recycle in the United States". The former report identified what will be needed to develop the Idaho National Laboratory into a world-class nuclear laboratory within a decade, and the latter report provided expert advice to help guide the development of new technology approaches to proliferation-resistant civilian nuclear fuel cycles.

NERAC's Subcommittee on Evaluations, formed in FY 2004, conducted independent program evaluations of NE's Generation IV Nuclear Energy Systems Initiative, Nuclear Power 2010 program, and the Advanced Fuel Cycle Initiative. The Subcommittee submitted its findings to the full NERAC in FY 2005, and they contributed to the formulation of this budget request. The Subcommittee will continue independently to evaluate and report on key NE programs at least annually. The Subcommittee

on Generation IV Nuclear Energy Systems, also formed in FY 2004, submitted its first report on the development of the Generation IV program to the full NERAC in FY 2005.

Program Assessment Rating Tool (PART)

The Department implemented a tool to evaluate selected programs. PART was developed by the OMB to provide a standardized way to assess the effectiveness of the Federal Government's portfolio of programs. The structured framework of the PART provides a means through which programs can assess their activities differently than through traditional reviews. The Nuclear Energy R&D program has incorporated feedback from OMB during the FY 2004-FY 2005 PART assessments into the FY 2006 Budget Request and has taken or will take the necessary steps to continue to improve performance.

The results of the FY 2005 review are reflected in the FY 2006 Budget Request as follows:
For the Nuclear Power 2010 program, an overall PART score of 69 was achieved with a perfect 100 score for Section I, Program Purpose & Design. A score of 89 was achieved for Section II, Strategic Planning reflecting the need to improve the linkage between budget and performance data at the Departmental level. A score of 88 was achieved for Section III, Program Management reflecting the need to measure and achieve cost effectiveness in program execution. A score of 45 was achieved for Section IV, Program Results/Accountability, indicating that the program needs to establish on an annual basis an independent assessment of the overall program, evaluating the program's progress against established annual and long-term goals. In addition, OMB did recognize that the NP 2010 is a relatively new program with limited progress in achieving its long-term goals. To address these findings, the Department has established an annual assessment process for the program, which will address the appropriateness, adequacy and completeness of current and planned activities for achieving the program goals and objectives.

For the Generation IV Nuclear Energy Systems Initiative, an overall PART score of 79 was achieved with perfect scores of 100 for Section I, Program Purpose & Design, and Section III, Program Management. These scores reflect the continued effective management of the program. A score of 90 was achieved for Section II, Strategic Planning reflecting the need to improve the linkage between budget and performance data at the Departmental level. A score of 60 was achieved for Section IV, Program Results/Accountability, which reflects the strengthening of long-term performance goals for the program compared with the previous year's performance goals. The need for improvements in the conduct of independent evaluations was identified. This area was strengthened in early FY 2004 by the establishment of the new NERAC Subcommittee on Evaluations.

For the Advanced Fuel Cycle Initiative (AFCI), an overall PART score of 76 was achieved with top scores of 100 in Section I, Program Purpose & Design, and Section III, Program Management. These scores are attributable to the continued use of effective program management practices. A score of 90 was achieved for Section II, Strategic Planning reflecting the need to improve the linkage between budget and performance data at the Departmental level. A score of 53 was achieved for Section IV, Program Results/Accountability, indicating the need to better demonstrate the cost effectiveness of the program. To address these findings, the program revised its near and long-term goals, and is working to increase cost effectiveness by continuing to increase international cost-shared research and development costs through expanded collaborations.

Funding by General and Program Goal

	(dollars in thousands)		
	FY 2004	FY 2005	FY 2006
General Goal 4, Energy Security Program Goal 04.14.00.00: Develop new nuclear generation technologies	118,292	165,679	191,000
All Other	9,273	4,961	0
Total General Goal 4 (Research and Development)	127,565	170,640	191,000

Other Information

Our Nation's investments in nuclear energy R&D are made to improve the quality of life, energy security, and economic prospects for the American people. Currently, 20 percent of our Nation's electricity is produced with emission-free nuclear power plants. The "National Energy Policy" calls for the expansion of nuclear energy in the United States. In support of this goal, the Department's nuclear energy R&D programs address two critical objectives:

Develop New Nuclear Generation Technologies:

U.S. electricity demand continues to grow at approximately two percent per year. Forecasts indicate that the United States will need about 335,000 megawatts of new generating capacity by 2025—even if ambitious assumptions are correct regarding the implementation of energy efficiency practices and technologies. If electricity demand grows at our current higher rates, even more generating capacity will be needed. This growth would require the United States to build between 1,000 and 1,200 new power plants over the next two decades. This averages to building and commissioning 50 to 60 new power plants per year. To help meet this need, the "National Energy Policy" recommends the expansion of nuclear energy in the United States, including the construction of new nuclear power plants.

The Nuclear Power 2010 program supports intermediate-term research, technology development and demonstration activities that advance the "National Energy Policy" goals of enhancing long-term U.S. energy independence and reliability and expanding the contribution of nuclear power to the Nation's energy portfolio. Because nuclear energy is the only large-scale, non-emitting energy source that can expand to meet growing demand and replace retiring fossil-fueled capacity over the next twenty years, efforts taken with industry to increase the production of nuclear-generated electricity are vital to meeting the country's energy and environmental goals.

The Nuclear Power 2010 program is focused on resolving the technical, institutional, and regulatory barriers to the deployment of new nuclear power plants by 2010, consistent with the recommendations of the NERAC report, "A Roadmap to Deploy New Nuclear Power Plants in the United States by 2010." In order to support the "National Energy Policy" and the President's goal of reducing greenhouse gas

intensity by 18 percent by 2012, the Nuclear Power 2010 program will help enable an industry decision to deploy at least one new advanced nuclear power plant in the U.S. early in the next decade.

Recognizing growing concerns worldwide about sustainable development, the Department started the Generation IV Nuclear Energy Systems Initiative. As documented in "A Technology Roadmap for Generation IV Nuclear Energy Systems", Generation IV advanced reactor and fuel cycle technologies are poised to play an important role in meeting the needs for electricity, hydrogen, clean water, and process heat. Generation IV Nuclear Energy Systems Initiative will meet these needs by:

- conducting research and development on thermal-spectrum Generation IV technology that can provides significant improvements in proliferation and terrorism resistance, safety and reliability, and economics, and demonstrate efficient electricity and hydrogen production; and

- conducting research and development, in collaboration with international partners, on fast-spectrum Generation IV nuclear energy systems for deployment in the longer-term future that, with successful Advanced Fuel Cycle Initiative research, provide significant improvements in proliferation and terrorism resistance, safety and reliability, economics, and long-term sustainability.

While contributing 17 percent of electricity generation worldwide, nuclear energy currently contributes only seven percent to the overall global energy requirements. Considering emerging issues such as sustainable development of world economies, the capacity of nuclear energy to deliver energy that is free from greenhouse gas emissions or other air pollutants offers a renewed incentive to consider a broadened, energy-intensive product mix. Nuclear technology, combined with advanced thermochemical or high-temperature electrolysis technologies, presents a very promising approach to produce hydrogen in a sustainable and environmentally friendly manner. A large market for hydrogen already exists in the fertilizer and petrochemical industries. Hydrogen and other synthetic chemical fuels are expected to find broadening application on world energy markets; the transportation sector has already begun a transition to hydrogen enrichment of fuels. The Nuclear Hydrogen Initiative is focused on the research, development and demonstration of a commercially viable, reactor-driven process for the large-scale production of hydrogen.

Beginning in FY 2004, the Department integrated the Nuclear Energy Research Initiative (NERI) activity directly into its mainline nuclear R&D programs to achieve greater participation of the Nation's university research community in these programs. The competitive solicitations for this research seek universities to conduct research that is focused specifically on programmatic issues for the Generation IV Nuclear Energy Systems Initiative, the Advanced Fuel Cycle Initiative, and the Nuclear Hydrogen Initiative. Funding for these research projects is provided directly from the budgets of these programs and will be devoted entirely to the research conducted at universities and colleges throughout the United States. The new approach to executing this research retains the independent peer review critical to ensuring the pursuit of leading-edge technologies, and integrates the Nation's universities into the Department's mainline nuclear R&D programs. Also, beginning in FY 2004, the Department used the bilateral I-NERI agreements implemented with other nations to continue international cost-shared R&D on the Generation IV Nuclear Energy Systems Initiative, the Advanced Fuel Cycle Initiative, and the Nuclear Hydrogen Initiative. This new approach to executing international, cost-shared research allows the Department to use all nuclear energy R&D programs as a basis for international, cost-shared R&D

thereby significantly increasing the amount of research achievable otherwise. Beginning in FY 2005, research on International Near Term Deployment technologies identified in the "Generation IV Technology Roadmap" by NERAC and the Generational IV International Forum that are relevant to U.S. technology needs will be conducted under the I-NERI sub-element of the Generation IV line item.

Develop Advanced, Proliferation-Resistant Nuclear Fuel Technologies:

As the United States considers the expansion of nuclear energy (as recommended in the "National Energy Policy"), it is clear that the Nation must optimize its approach to managing spent nuclear fuel. While the Yucca Mountain site may be sufficient to store all commercial spent fuel waste generated by existing nuclear power plants, the current "once-through" approach to the fuel cycle could require the United States to build additional repository space to assure the continued, safe management of nuclear waste from a new generation of nuclear plants. Further, long-term issues associated with the heat load and radiotoxicity of nuclear waste and the proliferation risks posed by plutonium in spent fuel remain.

To address these issues, the Department has embarked, with its international partners, on a research effort with both an intermediate-term and a long-term component. This program, the Advanced Fuel Cycle Initiative, seeks to develop advanced, proliferation-resistant nuclear fuel cycle technologies that can:

- enhance the design and reduce the long-term cost of the Nation's first geologic repository;
- reduce or eliminate the technical need for an additional repository;
- reduce the inventory of plutonium from commercial spent nuclear fuel; and
- recover the energy value of commercial spent nuclear fuel.

The development of the advanced fuels and fuel cycle technologies needed for the next-generation reactors under development in the Department's Generation IV Nuclear Energy Systems Initiative is also being conducted under the Advanced Fuel Cycle Initiative.

Nuclear Energy Plant Optimization

Funding Schedule by Activity

(dollars in thousands)

	FY 2004	FY 2005	FY 2006	$ Change	% Change
Nuclear Energy Plant Optimization					
Nuclear Energy Plant Optimization	2,863	2,412	0	-2,412	-100.0%
Small Business Innovative Research/Small Business Technology Transfer Program	0	68	0	-68	-100.0%
Total, Nuclear Energy Plant Optimization	2,863	2,480	0	-2,480	-100.0%

Description

The Nuclear Energy Plant Optimization (NEPO) program was started by the Department of Energy in FY 2000 to address the technical issues that may prevent the continued operation of existing nuclear power plants. Such technical issues include plant aging and improving plant reliability, availability, and productivity. The FY 2006 Budget proposes to terminate this program.

Benefits

NEPO research and development has made progress toward addressing material aging and generation optimization issues which have been identified by the industry as the long-term issues facing current operating plants. Currently, 30 of the 104 operating U.S. nuclear plants have received approval from the Nuclear Regulatory Commission to extend the operation of the nuclear plant for an additional 20 years for a total plant life expectancy of 60 years. Nearly all the U.S. nuclear plants are expected to seek and gain license renewal for this additional 20-year period of operation. As these nuclear plants mature, material aging and equipment degradation issues are being identified that affect continued operation of these plants. Examples of recent results from the NEPO program include new electrical cable monitoring techniques for improved prediction of cable lifetimes; development of techniques to qualify digital instrumentation transmitters to replace existing analog transmitters which are less accurate, difficult to maintain, or no longer available from the vendors; and the development of guidelines for the implementation of hybrid and digital control room technology. Further information about current projects and recent results of the NEPO program can be obtained at the NEPO web site (http://www.nuclear.gov).

The Nuclear Energy Research Advisory Committee (NERAC) provides the Department independent expert advice on the planning and execution of the NEPO program. NEPO research is coordinated with industry and R&D projects have been awarded on a competitive basis. Non-competitive awards are made when the R&D requires a unique facility or unique knowledge of and experience with the R&D being conducted.

No funding is requested for this activity in FY 2006.

Detailed Justification

(dollars in thousands)

	FY 2004	FY 2005	FY 2006
Nuclear Energy Plant Optimization	**2,863**	**2,412**	**0**

In FY 2004, R&D activities continued using prior year funds on 14 one-year projects that started in FY 2003. In FY 2004, two new one-year projects were initiated. One NEPO project is focused on techniques and methods for validation of enhanced nuclear plant security. The second FY 2004 NEPO project addresses issues related to commercial light water reactor fuel clad material degradation. In addition, the transfer of the Mechanical Stress Improvement Process Technology to the Ignalina plant in Lithuania was completed.

In FY 2005, activities will focus on addressing the affects of aging on material in nuclear plants. The program will use and further develop the capabilities on the newly formed Idaho National Laboratory to help resolve nuclear industry issues in this area. In particular, R&D activities related to commercial Light Water Reactor fuel degradation will continue.

No funding is being requested for FY 2006.

Small Business Innovative Research and Small Business Technology Transfer Programs	**0**	**68**	**0**
Total, Nuclear Energy Plant Optimization	**2,863**	**2,480**	**0**

Explanation of Funding Changes

	FY2006 vs. FY 2005 ($000)
Nuclear Energy Plant Optimization	
The funding decrease of $2,412,000 reflects no funds being requested in FY 2006	-2,412
Small Business Innovative Research and Small Technology Programs	
The funding decrease of $68,000 reflects no funds being requested in FY 2006	-68
Total Funding Change, Nuclear Energy Plant Optimization	**-2,480**

Nuclear Energy Research Initiative

Funding Schedule by Activity

(dollars in thousands)

	FY 2004	FY 2005	FY 2006	$ Change	% Change
Nuclear Energy Research Initiative					
Nuclear Energy Research Initiative	6,410	2,415	0	-2,415	-100.0%
Small Business Innovative Research/Small Business Technology Transfer Program	0	66	0	-66	-100.0%
Total, Nuclear Energy Research Initiative	6,410[a]	2,481	0	-2,481	-100.0%

Description

The Nuclear Energy Research Initiative (NERI), started in 1999, has conducted research to advance the state of nuclear science and technology in the United States by addressing technical issues impacting the expanded use of nuclear energy. Specifically, the NERI program has focused on research and development on next-generation nuclear energy systems, proliferation resistant nuclear fuel cycle technologies, generation of hydrogen using nuclear power, improvements in light water reactor technology, and fundamental areas of nuclear science that directly impact the long-term success of nuclear energy. In FY 2004, the Department integrated the Nuclear Energy Research Initiative (NERI) activity directly into its mainline nuclear R&D programs - the Generation IV Nuclear Energy Systems Initiative (Generation IV), the Advanced Fuel Cycle Initiative (AFCI), and the Nuclear Hydrogen Initiative (NHI)- to achieve greater participation of the Nation's universities in these National R&D programs.

Benefits

NERI featured a competitive, investigator-initiated, peer-reviewed selection process to fund innovative nuclear energy-related research. Modeled after successful research programs such as those conducted by the National Science Foundation and DOE's Office of Science, the NERI program solicited proposals from the U.S. scientific and engineering community for research at universities, national laboratories, and industry. NERI encouraged collaborative research and development activities among these different research organizations, as well as participation of research organizations funded by other nations. The Nuclear Energy Research Advisory Committee (NERAC) provided oversight and advice on the planning and implementation of the NERI program.

The NERI research effort, conducted by the Nation's university, laboratory and industry partners, has helped to maintain the nuclear research infrastructure in this country and has focused attention on the United States as a nuclear research and development leader. Research accomplishments include: reactor system and plant infrastructure concepts that utilize nuclear energy to produce hydrogen; new advanced controls, diagnostic techniques and information systems for potential use in automating future

[a] For comparability purposes, the I-NERI funding has been included in the Generation IV Nuclear Energy Systems Initiative program. In FY 2004, the I-NERI funding is $4.2M of which $0.116M is SBIR/STTR.

nuclear plants; high temperature ceramic materials that could allow higher burn-ups resulting in maximized energy production and improved plant economics; evaluation of direct energy conversion technologies for advanced nuclear power plants; and reactor physics data for advanced nuclear power systems. By funding innovative nuclear research at the Nation's universities, the NERI program has stimulated student enrollment in nuclear fields of study. Further highlights of the NERI program are contained in the "Nuclear Energy Research Initiative 2003 Annual Report" (see http://neri.ne.doe.gov/).

Beginning in FY 2004, the Department integrated the Nuclear Energy Research Initiative (NERI) activity directly into its mainline nuclear R&D programs to achieve greater participation of the Nation's university research community in these programs. The competitive solicitations for NERI research seek universities to conduct research that is focused specifically on programmatic issues for Generation IV Nuclear Energy Systems Initiative, Advanced Fuel Cycle Initiative and Nuclear Hydrogen Initiative. Funding for these research projects comes directly from the budgets of these programs and is devoted to research conducted at universities and colleges throughout the United States. The new approach to executing NERI research retains the independent peer review critical to ensuring the pursuit of leading-edge technologies, and integrates the Nation's universities into the Department's mainline nuclear R&D programs. Funds appropriated in FY 2005 for the NERI program will be used in conjunction with FY 2004 and FY 2005 funds provided by the mainline R&D programs to award 35 cooperative agreements to U.S. universities to conduct research on the Generation IV, AFCI, and the NHI programs. As the NERI activities are integrated into the Department's mainline nuclear R&D programs, no funding is requested in FY 2006 for a stand-alone NERI program.

Detailed Justification

(dollars in thousands)

	FY 2004	FY 2005	FY 2006
Nuclear Energy Research Initiative	**6,410**	**2,415**	**0**

The NERI program conducts research and development on next-generation nuclear energy systems, proliferation resistant nuclear fuel cycle technologies, generation of hydrogen using nuclear power, improvements in light water reactor technology, and fundamental areas of nuclear science that directly impact the long-term success of nuclear energy. Beginning in FY 2004, new NERI research projects support the Generation IV, AFCI and NHI programs and are conducted by U.S. universities.

In FY 2004, the Department began to integrate the NERI activity directly into its mainline nuclear R&D programs. Solicitations were issued in late FY 2004 and the selection of 35 cooperative agreements will be awarded in early 2005 to U.S. universities to conduct research on the Generation IV, AFCI and the NHI programs.

In FY 2006, no funding is requested in the NERI program as the mainline R&D programs will provide funding for the NERI university awards.

(dollars in thousands)

	FY 2004	FY 2005	FY 2006
Small Business Innovative Research and Small Business Technology Transfer Programs (SBIR/STTR)	**0**	**66**	**0**
Total, Nuclear Energy Research Initiative	**6,410**	**2,481**	**0**

Explanation of Funding Changes

	FY 2006 vs. FY 2005 ($000)
Nuclear Energy Research Initiative	
The decrease of $2,415,000 is due to no funding being requested in FY 2006 for the NERI program; all NERI projects are being funded by the Generation IV, AFCI and NHI programs in FY 2006	-2,415
Small Business Innovative Research and Small Technology Programs	
The decrease of $66,000 is due to no NERI funding being requested in FY 2006	-66
Total Funding Change, Nuclear Energy Research Initiative	**-2,481**

Nuclear Power 2010

Funding Schedule by Activity

(dollars in thousands)

	FY 2004	FY 2005	FY 2006	$ Change	% Change
Nuclear Power 2010	19,360	49,605	56,000	+6,395	+12.9%
Total, Nuclear Power 2010	19,360	49,605	56,000	+6,395	+12.9%

Description

The Nuclear Power 2010 program supports intermediate-term research, technology development and demonstration activities that advance the "National Energy Policy" (NEP) goals of enhancing long-term U.S. energy independence and reliability and expanding the contribution of nuclear power to the Nation's energy portfolio. Because nuclear energy is the only large-scale, non-emitting energy source that can expand to meet growing demand and replace retiring fossil-fueled capacity over the next twenty years, efforts taken with industry to increase the production of nuclear-generated electricity are vital to meeting the country's energy and environmental goals.

Nuclear Power 2010 is a joint government/industry cost-shared effort to: identify sites for new nuclear power plants, develop and bring to market advanced standardized nuclear plant designs, evaluate the business case for building new nuclear power plants, and demonstrate untested regulatory processes. These efforts are designed to pave the way for an industry decision in the next few years to seek Nuclear Regulatory Commission approval to build and operate a new advanced nuclear power plant in the United States.

The Department is actively engaged with the industry to address the issues affecting future expansion of nuclear energy in this country. The Department and the private sector have identified specific issues to be addressed through cooperative research, technology development, analysis, and regulatory demonstration activities. The objectives of these activities are focused on the expansion of nuclear generation capacity through deployment of new nuclear plants.

Benefits

Electricity demand in the United States is expected to grow sharply in the 21st century, requiring new generation capacity. Forecasts indicate that the United States will need about 335,000 megawatts of new generating capacity by 2025 - even if ambitious assumptions are correct regarding the implementation of energy efficiency practices and technologies. If electricity demand grows at our current higher rates, even more generating capacity will be needed. This growth would require the United States to build between 1,000 and 1,200 new power plants over the next two decades. This averages to building and commissioning 50 to 60 new power plants per year.

With about 20 percent of our Nation's current electricity production generated by nuclear power plants, the Department believes it is important to deploy new baseload nuclear generating capacity within a decade. This goal supports the "National Energy Policy" objectives of energy supply diversity and

energy security. In order to maintain nuclear power's electricity share to meet future electricity demand, the technical, regulatory, and institutional barriers, which currently exist, must be successfully addressed by government and industry. More specifically, major obstacles to building new nuclear plants include the uncertainties associated with Federal regulatory processes, the initial high capital costs of the first nuclear plants and the business risks resulting from these uncertainties. The Nuclear Power 2010 program was designed to address these obstacles by partnering with industry to achieve near-term expansion of nuclear energy. This program also implements "National Energy Policy" recommendations to expand the role of nuclear energy in the United States.

A Near-Term Deployment Working Group, operating under the auspices of the Nuclear Energy Research Advisory Committee (NERAC), and composed of representatives from the nuclear industry, national laboratories, and United States universities, initiated a concerted effort in FY 2001 to identify the technical, institutional, and regulatory barriers to the deployment of new nuclear power plants by the end of the decade. On October 31, 2001, the working group issued, "A Roadmap to Deploy New Nuclear Power Plants in the United States by 2010," which recommends action to be taken by industry and the Department to support deployment of new advanced nuclear power plants in the United States by 2010 (see http://nuclear.gov/nerac/ntdroadmapvolume1.pdf). The analysis from NERAC notes that research and development on near-term advanced reactor concepts that offer enhancements to safety and economics is needed to enable these new technologies to be competitive in the deregulated electricity market. The recommendations of the near-term deployment roadmap, which have broad industry support, provide the basis for the activities of the Nuclear Power 2010 program.

The technology focus of the Nuclear Power 2010 program is on Generation III+ advanced light water reactor designs which offer advancements in safety and economics over the Generation III+ designs certified in the 1990s by the Nuclear Regulatory Commission. To reduce the regulatory risks and enable the deployment of new Generation III+ nuclear power plants in the United States, it is essential to demonstrate the untested Federal regulatory and licensing processes for the siting, construction, and operation of new nuclear plants. In addition, design development and Nuclear Regulatory Commission certification of these near-term Generation III+ advanced reactor concepts is needed to reduce the high initial capital costs of the first new plants such that these new technologies can be competitive in the deregulated electricity market and deployable within the next decade.

The economics and business case for building new nuclear power plants is also being evaluated as part of the Nuclear Power 2010 program to identify the necessary conditions under which power generation companies would add new nuclear capacity. In July 2002, the Department released the "Business Case for New Nuclear Power Plants in the United States," which presents the results of this evaluation and provides recommendations for Federal government assistance (see http://nuclear.gov/home/bc/businesscase.html). The Department continues to evaluate and develop strategies to mitigate specific financial risks identified in this report associated with deployment of new nuclear power plants. The Department also sponsored an independent study by the University of Chicago's Department of Economics that examined the economic viability of new nuclear power plants in the United States and considered the possible effectiveness of temporary federal government policies to assist in the competitiveness of the first few new plants. The results of the study are documented in the September 2004 report, "The Economic Future of Nuclear Power" (see http://nuclear.gov/NucPwr2010/NucPwr2010_PI.html). The information obtained from these studies is used to focus the program's activities on issues of the greatest impact.

The Nuclear Power 2010 program incorporates competitive procurement processes for the regulatory demonstration and design development activities and requires a minimum of 50 percent industry cost-share for these program activities. Through the competitive procurement process, the Department has successfully encouraged industry to form consortia—innovative business arrangements among power generation companies, reactor vendors and architect-engineers—that have strong incentives to build and operate new nuclear plants in the United States. This consortium approach is designed to advance real plans for building new nuclear power plants and to ensure that investments for standardized design development are directed toward those advanced reactor technologies which power companies are willing to build.

To demonstrate the new untested regulatory process for obtaining U.S. Nuclear Regulatory Commission (NRC) approval for siting a new nuclear power plant, the Department established competitively selected, cost-shared cooperative agreements in FY 2002 with three nuclear power generating companies to obtain Early Site Permits (ESP) for three commercial sites. The ESP process includes resolution of site safety, environmental and emergency planning issues in advance of a power company's decision to build a new nuclear power plant. In fall of 2003, the three power generation companies, working under the auspices of the Nuclear Power 2010 program, prepared and submitted ESP applications for NRC approval. Currently, the three ESP applications are undergoing NRC staff review. To identify additional qualified sites, the Department initiated additional cost-shared studies in FY 2003 and FY 2004 to prepare technical (*e.g.* geotechnical, geological and seismological) and financial evaluations and to assess the electricity transmission impacts associated with siting a new commercial nuclear plant. ESP demonstration project tasks in FY 2005 will focus on industry activities to assure timely completion of the NRC staff and Advisory Committee on Reactor Safeguards (ACRS) reviews of the ESP applications and Atomic Safety and Licensing Board (ASLB) hearings. NRC issuances of ESPs are expected in FY 2006.

To demonstrate the new untested regulatory process for obtaining NRC approval for constructing and operating a new nuclear power plant, the Department will implement combined Construction and Operating License (COL) regulatory demonstration projects. The COL process is a "one-step licensing" process established by the Energy Policy Act of 1992 and intended to resolve all public health and safety issues associated with the construction and operation of a new nuclear power plant before construction begins. In FY 2003, the Department initiated a cost-shared project with the industry to develop generic guidance for preparing a COL application and to resolve anticipated generic COL regulatory issues. This project, to be concluded in FY 2006, will result in an NRC-reviewed guidance document available for industry to use in preparing COL applications.

In November 2004, the Department selected two utility-led consortia to initiate New Nuclear Plant Licensing Demonstration Projects and to obtain an NRC license to construct and operate new nuclear power plants in the United States. In responding to the Department's solicitation issued in FY 2004, these consortia provided specific plans that the utilities believe could lead to groundbreaking activities for new U.S. nuclear power plants by 2010. This engineering, regulatory demonstration, and analysis work will complete the steps necessary to allow one or more nuclear plants to be ordered by the end of 2008. The work includes design certification and completion efforts related to state-of-the-art Generation III+ nuclear plant designs; site-specific analysis and engineering required to obtain Combined Construction/Operating Licenses from the NRC; and other activities required to allow for a utility order for a new plant to proceed.

A third consortium was awarded cost-shared funding in FY 2004 to conduct a detailed cost and schedule analysis of the potential construction of a Generation III+ nuclear power plant in Alabama. This work is scheduled to be completed in late FY 2005. The three consortia now active under the Nuclear Power 2010 program represent four advanced reactor technology suppliers and 12 power generation companies that operate more than two-thirds of all the U.S. nuclear power plants in operation today.

Detailed Justification

(dollars in thousands)

	FY 2004	FY 2005	FY 2006
Nuclear Power 2010	**19,360**	**49,605**	**56,000**

During FY 2004, the Department made significant progress toward evaluating sites and candidate technologies for building new nuclear power plants and working with industry to resolve associated regulatory issues. Specifically, the Department:

- Continued the Early Site Permit (ESP) demonstration projects with resolution of site-specific issues arising from the NRC review of the ESP applications. Two of the three ESP applications were submitted to NRC in FY 2003 and the third ESP application was submitted in early FY 2004. Successful resolution of these site issues will lead to issuance of ESPs in FY 2006 thus providing three NRC approved sites that will be available for the construction of new nuclear power plants.
- Continued the nuclear plant site suitability study initiated in FY 2003. Activities in FY 2004 focused on conducting technical evaluations (*e.g.* geotechnical, geological and seismological) and assessing the electricity transmission impacts associated with siting a new commercial nuclear plant. Completion of this study will provide key information to support the power company decision to proceed with a combined Construction and Operating License (COL) to construct a nuclear power plant.
- Initiated a Texas Gulf Coast Nuclear Power Plant Feasibility Study to explore the feasibility of siting, licensing, financing, and construction of a privately funded new nuclear power plant in Texas to meet the growing and diverse energy requirements in the Texas Gulf Coast area.
- Completed a nuclear construction technology assessment initiated in FY 2003 that independently evaluated the schedule and construction methods of advanced nuclear plant designs. This assessment provides important input to the power generation companies for their technology selection for the next nuclear power plant to be built in the United States.
- Continued the industry cost-shared project initiated in FY 2003 to develop generic guidance for the combined Construction and Operating License (COL) application preparation and to resolve generic COL regulatory issues. This project, to be concluded in FY 2006, will make an NRC-reviewed guidance document available to power generation companies for use in preparing COL applications.
- Completed a macroeconomic study initiated in FY 2003 on the economic viability of new nuclear power plants in the United States and the effectiveness of temporary federal government policies to assist in the competitiveness of the first few new plants.

(dollars in thousands)

FY 2004	FY 2005	FY 2006

- Issued a solicitation in FY 2004 to invite proposals from power generation company-led teams for New Nuclear Plant Licensing Demonstration Projects to demonstrate the untested COL regulatory process. Demonstration of this process is essential to building new nuclear power plants. Under these cost-shared projects, power companies will conduct studies, analyses, and other activities necessary to make technology selections and prepare site-specific, technology-specific COL applications. In FY 2004, review and evaluation of the three industry consortia proposals was completed and one project was initiated to conduct cost and schedule studies to enable a decision by the power company on proceeding with preparing a COL application.

In FY 2005, the Department will make significant progress toward obtaining NRC approval of potential sites for building new nuclear power plants. Progress will also be made toward completing activities to enable a power generation company decision to proceed with preparing a COL application. Specifically, the Department will:

- Continue the ESP demonstration projects by supporting resolution of site-specific issues arising from the NRC review of the ESP applications. Final NRC Safety Evaluation Reports are projected to be completed in FY 2005.
- Complete the commercial nuclear plant site suitability study initiated in FY 2003 potentially making another site available in Alabama for building new nuclear plants. Results of this study will be used by the power company to make decisions on proceeding with a COL application to construct a new nuclear power plant.
- Complete the Texas Gulf Coast Nuclear Power Plant Feasibility Study initiated in FY 2004. This study will prepare the business and technical case for constructing a privately financed nuclear power plant to serve the needs of general public and industry end-users in the Texas Gulf Coast region.
- Continue the industry cost-shared project initiated in FY 2003 to develop generic guidance for the COL application preparation and to resolve generic COL regulatory issues. A draft guidance document will be completed and provided to the NRC for review.
- Begin the New Nuclear Plant Licensing Demonstration Projects. Cost and schedule evaluation by one power generation company-led team selected in FY 2004 will be completed. Two additional projects to demonstrate the COL process will be initiated. One of these project teams seeks to obtain a COL for a site in Virginia while the second will proceed with evaluations to select one or two sites over the next year. Both projects will begin with the development of detailed project cost and schedule information, establishment of a DOE interface/project oversight agreement, and other milestones specific to each project.

In FY 2006, the Department will:

- Complete the ESP demonstration projects with issuance of three Early Site Permits by the NRC. This will make three NRC approved sites available for building new nuclear power plants. Activities in FY 2006 will focus on completing final project reports documenting lessons learned and recommendations for future ESP applicants.
- Complete the industry cost-shared project initiated in FY 2003 to develop generic guidance for

(dollars in thousands)

FY 2004	FY 2005	FY 2006

the COL application preparation and to resolve generic COL regulatory issues. This will make NRC approved guidance available to power generation companies for use in preparing COL.

- Continue the implementation phase of the two New Nuclear Plant Licensing Demonstration Projects awarded in FY 2005. The implementation phase for both projects will include preparation of combined Construction and Operating License (COL) applications and approval by the NRC, and confirmatory financial evaluations and other technical activities necessary to enable the power companies to make decisions on ordering and building at least one new nuclear power plant. These activities will be conducted in an integrated manner to efficiently achieve the Nuclear Power 2010 program's overall objectives.

Total, Nuclear Power 2010	**19,360**	**49,605**	**56,000**

Explanation of Funding Changes

	FY 2006 vs. FY 2005 ($000)
Nuclear Power 2010	
Nuclear Power 2010 solicitations and proposals for regulatory demonstration projects were received and evaluated in FY 2004, demonstrating the encouraging interest of the industry in this joint government/industry cost-shared effort. Following an evaluation of the proposals, two New Nuclear Plant Licensing Demonstration Projects were awarded in FY 2005. Based on the progress to date, in FY 2006 the program will continue the implementation phase of the two projects awarded in FY 2005. The increase of $6,395,000 allows these projects to proceed on a schedule more in line with what was proposed by industry.	+6,395
Total Funding Change, Nuclear Power 2010	**+6,395**

Generation IV Nuclear Energy Systems Initiative

Funding Schedule by Activity

(dollars in thousands)

	FY 2004	FY 2005	FY 2006	$ Change	% Change
Generation IV Nuclear Energy Systems Initiative					
Generation IV R&D	22,897	34,753	39,753	+5,000	+14.4%
International Nuclear Energy Research Initiative	4,084	4,060	4,060	0	+0.0%
Small Business Innovative Research and Small Business Technology Transfer Programs	0	870	1,187	+317	+36.4%
Total, Generation IV Nuclear Energy Systems Initiative	26,981[a]	39,683	45,000	+5,317	+13.4%

Description

The goal of the Generation IV Nuclear Energy Systems Initiative is to address the fundamental research and development issues necessary to establish the viability of next-generation nuclear energy system concepts. Successfully addressing the fundamental research and development issues of Generation IV system concepts that excel in safety, sustainability, cost-effectiveness and proliferation-resistance will allow these advanced systems to be considered for commercial development and deployment by the private sector, thus realizing their considerable promise for the future.

Benefits

The Department's strategic plan lays the ground work of the ambitious, long-term vision of a zero-emission future, free of the reliance on imported energy. The Generation IV Nuclear Energy Systems Initiative is a vital component of this vision and takes up the mission of securing nuclear energy as a viable, long-term commercial energy option to provide diversity in the energy supply. The Generation IV Nuclear Energy Systems Initiative will work to develop new nuclear energy systems that can compete with advanced fossil and renewable technologies, enabling power providers to select from a diverse group of generation options that are economical, reliable, safe, secure, and environmentally acceptable.

Demand for electricity in the United States is expected to increase sharply in the 21st century. Forecasts indicate that the United States will need about 335,000 megawatts of new generating capacity by 2025 - even accounting for ambitious implementation of energy efficiency practices and technologies. Should demand for energy continue to grow at current rates, the United States would need to construct between 1,000 and 1,200 new power plants over the next two decades - about 50 to 60 new power plants per year.

[a] For comparability purposes, the I-NERI funding has been included in the Generation IV Nuclear Energy Systems Initiative program. In FY 2004, the I-NERI funding is $4.2M of which $0.116M is SBIR/STTR.

To help meet this need for new electricity generation, the "National Energy Policy" (NEP) has recommended expansion of nuclear energy in the United States as a major component of our Nation's energy picture. As new power plants are built and older ones are retired, there will be a shift to technologies that have fewer air emissions than those presently deployed. In the President's Clear Skies and Climate Change Initiatives, nuclear energy is highlighted as a greenhouse gas free source of power for our Nation. Finally, in FY 2003, the President launched the Hydrogen Fuel Initiative. The hydrogen economy will require vast quantities of green-house gas free energy for the production of hydrogen. Advanced nuclear energy systems have the potential to meet a significant portion of that need.

While current nuclear power plant technology has proven to be an efficient means to produce baseload quantities of emissions-free energy, new technologies will be needed to enable an expansion in the use of nuclear energy over the long-term future. Over the coming decades, the Department believes that Generation IV nuclear energy systems can play a vital role in fulfilling the Nation's needs for low cost and efficient electricity and commercial quantities of hydrogen. Generation IV systems represent a new generation of nuclear energy technologies that can be made available in the 2020-2030 timeframe, and offer significant advances in the areas of sustainability, proliferation resistance and physical protection, safety, and economics.

Next-generation nuclear energy systems are being developed with new features to provide power systems that can serve a vital role in the Nation's long-term, diversified energy supply. High operating temperatures and improved efficiencies make some Generation IV systems ideal for providing clean burning hydrogen needed to power fuel cell driven vehicles in the future. Growing concerns for the environment favor energy sources that can satisfy the need for electricity and other energy-intensive products on a sustainable basis with minimal environmental impact. Advances in sustainability entail improvements in fuel utilization and waste management. Advances in proliferation resistance and physical protection will further decrease the possibility that nuclear plants could prove to be viable targets for terrorist groups or that nuclear materials present in civilian fuel cycles could be diverted to make weapons. Advances in safety—with a goal of eliminating the need for offsite emergency response—will improve public confidence in the safety of nuclear energy while providing improved investment protection for plant owners. Advances in economics will ensure competitive life cycle cost and acceptable financial risk. Generation IV nuclear energy systems will not only be safe, economic, and secure but also include energy conversion systems that produce non-electricity products such as hydrogen, desalinated water, and process heat. These features make Generation IV reactors ideal for meeting the President's energy and environmental objectives.

To guide the development of Generation IV reactor designs, a "Technology Roadmap for Generation IV Nuclear Energy Systems (Roadmap)" was prepared under the auspices of the Department's independent Nuclear Energy Research Advisory Committee (NERAC) and the Generation IV International Forum (GIF). GIF is a formal, chartered organization of governments with representatives from Argentina, Brazil, Canada, France, Japan, the Republic of Korea, the Republic of South Africa, Switzerland, the United Kingdom, EURATOM, and the United States. "The Roadmap", prepared by nearly one hundred experts from GIF countries and international organizations, was issued in March 2003 and outlines the benefits, the technical and institutional barriers, and the research needs for the most promising nuclear energy system concepts. "The Roadmap" identified the six most promising nuclear energy systems, complete with fuel cycle, power conversion, waste management, and other nuclear infrastructure elements. These systems are the Very-High-Temperature Reactor (VHTR), the Supercritical Water-Cooled Reactor (SCWR), the Gas-Cooled Fast Reactor (GFR), the Lead-Cooled Fast Reactor (LFR), the

Sodium-Cooled Fast Reactor (SFR), and the Molten Salt Reactor (MSR). "The Roadmap" also serves as the organizing basis for national, bilateral, and multilateral research and development activities for the development of Generation IV systems.

Work continues across the breadth of Generation IV technologies. That said, the great advantage of the high degree of international cooperation inherent to the Generation IV process (which is coordinated by the 11-member Generation IV International Forum) is the fact that not all countries need conduct primary efforts in all technologies. The Generation IV International Forum, or GIF, has developed an international approach to research that places one country in the lead of a given system. Other countries can participate in research in any system that interests them to whatever degree they find appropriate. Japan, for example, is lead country on the Sodium-Cooled Fast Reactor; France on the Gas-Cooled Fast Reactor; and Canada on the Supercritical Water-Cooled Reactor.

Because it features high power densities, large economies of scale, and improved electrical conversion efficiencies to economically generate electricity in large central stations, the Department plans cooperative research with its international partners to explore the Supercritical-Water-Cooled Reactor. The Lead-Cooled Fast Reactor, the Gas-Cooled Fast Reactor, and the Sodium-Cooled Fast Reactor have potential for acting in concert with Advanced Fuel Cycle Initiative (AFCI) technologies to transmute the actinide components of spent nuclear fuel into far shorter-lived, less toxic species. The Department plans to work closely with the lead countries for each of these technologies, performing cooperative research and development as appropriate to allow the United States to select a lead fast reactor technology for future, focused research and development. Roughly a third of the DOE Generation IV Nuclear Energy Systems Initiative is focused on cooperative research on technologies in which other countries have the primary technical lead, but in which the Untied States has interest.

The FY 2006 Budget expands research and development that could help achieve the desired goals of sustainability, economics, and proliferation resistance. Further investigation of technical and economic challenges and risks, including waste products, will help inform a decision on whether to proceed with a demonstration of the Next Generation Nuclear Plant, which would use very high temperature reactor technologies to economically produce both electricity and hydrogen gas. Key to the strategy for conducting all Generation IV research and development is the multiplication effect derived from international collaboration. By coordinating U.S. efforts with those of the GIF partner nations; our funding is leveraged by a factor of two to ten, depending on the reactor concept involved.

Funding for International Near Term Deployment (INTD) work identified by NERAC and GIF in the Generation IV Technology Roadmap that is relevant to U.S. technology needs is included in the Generation IV Nuclear Energy Systems Initiative program. International, cost-shared R&D enhances the Department's ability to leverage its limited research funding with nuclear technology research funding from other countries while also providing the United States greater credibility and influence in international activities associated with the application of nuclear technologies. The Department currently has in place bilateral International Nuclear Energy Initiative agreements with France, the Republic of Korea, the Organization of Economic Cooperation and Development Nuclear Energy Agency, the European Union, Canada, Brazil, and Japan. Negotiations to establish new agreements are underway with the Republic of South Africa, and the United Kingdom.

Finally, the Department's Office of Nuclear Energy, Science and Technology (NE) is working in close cooperation with the Office of Science (SC) through the "Materials for Advanced Energy Systems

Initiative" to coordinate research to develop advanced materials for use in Generation IV nuclear energy systems, fusion energy systems, and advanced energy technologies such as hydrogen production systems. Through a joint working group, the offices are coordinating on energy materials related issues with the purpose of investigating materials behavior in high temperature, radiation, and hostile corrosive environments, as well as the fabrication and non-destructive evaluation or monitoring of such materials. As common projects are identified, the offices will work to establish research objectives and cooperative work plans to leverage research funding.

Detailed Justification

(dollars in thousands)

	FY 2004	FY 2005	FY 2006
Generation IV R&D	**22,897**	**34,753**	**39,753**

Very-High-Temperature Reactor: The Department plans to work closely with both the international community and the U.S. private sector to continue research on the Very High Temperature Reactor. DOE intends to continue its effort to investigate the challenges and risks of VHTR technology, including costs and waste products. The ongoing research and development activities begun in FY 2003 and carried through FY 2005 will continue to analyze very high temperature reactor enabling technologies such as high temperature materials and graphite particle fuels. This R&D will be conducted in close cooperation and association with the member nations of the Generation IV International Forum. In FY 2004, the Department focused on developing a high-burnup VHTR particle fuel that can withstand postulated accident conditions while maintaining the integrity of the fuel and retaining the fission products within the kernel. Work also in developing design data needs for such key components as the reactor vessel and Brayton cycle turbine-generator. The Department remains optimistic about the potential for a future collaboration with countries such as France, Japan, and the Republic of Korea to demonstrate this technology.

In FY 2004, the following activities were supported:

- The point design for VHTR was completed to support the specification of critical fuel parameters necessary to advance the fuel qualification program. The point design establishes overall system parameters including nuclear thermal heat generation, fuel kernel temperatures during normal operation, reactor coolant flow rates and vessel material operating temperatures.
- Parametric evaluations of TRISO fuel particle coating (three layers of coatings) were conducted using small coaters to better understand and optimize the TRISO coating process.
- An inspection capability for quality control of TRISO coated particles and fuel compacts was established.

A compacting process to agglomerate fuel particles into a suitable shape for loading into a reactor core was developed. These efforts allowed for development of improved compact processing at a lower cost, and demonstrate the improved TRISO fuel/compact performance at higher temperatures for the VHTR.

(dollars in thousands)

FY 2004	FY 2005	FY 2006

In FY 2005, the Department is focused on VHTR fuel fabrication and qualification testing, systems integration studies, materials development and testing, and program planning. The following activities are being conducted:

- Publish a research and development plan to guide the materials, fuel, and codes and methods research and development that is broadly applicable across VHTR candidate technologies.
- Analyze candidate materials meeting the requirements for ultra-long-life power conversion components in high-temperature helium and salt environments. Because of the exposure to extreme heat, pressure and irradiation, these candidate materials are breaking new scientific ground in performance and consist of new age high-temperature metals, ceramics, and composites for critical structural, heat and radiation attenuation, and intermediate heat exchange components.
- Complete fabrication of irradiation test fuel specimens and the multi-cell capsule and test train for the initial irradiation tests.
- Begin planning and design activities for the second fuel qualification tests for the baseline TRISO fuel design. This second test campaign will irradiate the reference TRISO fuel and provide required information for the VHTR fuel design activities.
- Initiate development of advanced TRISO fuel characterization techniques.
- Conduct a comprehensive evaluation of candidate VHTR reactor technologies.

In FY 2006, the Department will:

- Develop and issue a detailed VHTR research and development plan that identifies all outstanding technology data needs and associated schedules for meeting them.
- Initiate the irradiation of TRISO fuel in the new ATR multi-cell capsule and test train to provide shakedown test information.
- Complete the consolidation of existing phenomenological models into an integrated fuel performance model.
- Begin scale-up of the TRISO fuel coater and fabrication process from laboratory-scale to an intermediate scale to evaluate coater diffuser and flow distribution effects. Reference VHTR TRISO fuel and design fuel variants will be produced for future testing.
- Complete the design and fabrication of a low flux irradiation fixture and initiate irradiations of candidate reactor pressure vessels steels.
- Complete preliminary high-flux irradiations and initiate post-irradiation examination of potential metallic alloys for reactor internals and initiate mechanical testing of candidate materials in the VHTR coolant environment.
- Purchase pre-production lots of candidate graphite and support American Society for the Testing of Materials standard materials specification development for VHTR graphite.
- Develop models to predict the behavior of candidate VHTR pressure boundary materials and very high-temperature component materials under expected operating conditions.

(dollars in thousands)

FY 2004	FY 2005	FY 2006

Lead-Cooled Fast Reactor: The Lead-Cooled Fast Reactor (LFR) concept is a lead or lead-bismuth-cooled small modular reactor with a closed fuel cycle. The design features a long-lived core (15-30 years), replaceable as an integral unit with vessel and coolant for high proliferation resistance. The LFR will utilize the advantages of lead or lead-bismuth eutectic (LBE) coolant to achieve high core outlet temperatures, which will allow realization of high system efficiency and/or production of hydrogen using high-temperature processes. Efficiency improvements with either lead or LBE might be obtained through the use of an innovative energy conversion system with supercritical carbon-dioxide as the working fluid. The reactor will accommodate a closed fuel cycle while ensuring substantial proliferation resistance by limiting access to fuel and associated fuel handling infrastructure. Generation IV International Forum (GIF) partner countries including Japan, Switzerland, and Korea have expressed interest in exploring this concept in cooperation with the United States.

In FY 2004, research and development was conducted as follows:

- Completed reference point designs; evaluated and selected a preferred concept. This activity supported core physics and thermal-hydraulic designs of proposed design concepts. Emphasis was placed on meeting design objectives, such as long-lifetime cores for enhanced proliferation resistance, passive safety, and autonomous load following. Conducted limited materials screening tests for compatibility with lead alloy coolant.

- Developed analysis tools and a refueling approach. Incorporated computer models and LFR-related properties for coolant, structural materials, and fuels into analysis codes to be used for core physics design, thermal-hydraulic design, and lead alloy coolant flow characteristics. Conducted core configuration and fuel-loading studies to determine design features necessary to accommodate 10, 20, and 30-year core lives.

In FY 2005, research and development in LFR is focusing on the following activities:

- Completing a point design of the reference LFR reactor and associated system components to sufficient level of detail to permit the start of preliminary concept design in FY 2006.

- Completing the analysis of materials test specimens which have completed 1000 hours of corrosion testing in the lead-bismuth DELTA loop, and continuing the testing of additional test specimens.

- Completing the design of a new liquid-lead high-temperature, natural-circulation test loop. Lead Fast Reactor materials research and development will be closely coordinated with the Office of Science research on materials to accelerate advancement of this technology.

In FY 2006, LFR research and development will focus on the following activities:

- LFR materials testing and analysis will continue with the objective of selecting key structural materials and cladding for lead-bismuth compatibility. Lead and lead-bismuth research will be expanded and will include the fabrication of a high-temperature liquid-lead experiment at the

Idaho National Laboratory. LFR materials research and development will be closely coordinated with the Office of Science to leverage and accelerate the understanding of materials corrosion, particularly in the area of irradiation testing.

- Complete the preliminary concept design of the LFR reactor and associated systems. This includes analyses to ensure that the systems meet design objectives of 15-30 year core refueling intervals for enhanced proliferation resistance, natural circulation and other passive safety features, and autonomous load-following.

Gas-Cooled Fast Reactor: The Gas-Cooled Fast Reactor (GFR) system features a fast-spectrum, helium-cooled reactor and closed fuel cycle as the reference concept. Like thermal-spectrum helium-cooled reactors such as the Very High Temperature Reactor, the high outlet temperature of the helium coolant makes it possible to deliver electricity, hydrogen, or process heat with high conversion efficiency. The GFR uses a direct-cycle helium turbine for highly-efficient electricity production. An alternate GFR concept which uses supercritical carbon-dioxide as the coolant may offer similar high efficiency while maintaining lower coolant temperatures. The GFR's fast neutron spectrum makes it possible to utilize available fissile and fertile materials (including depleted uranium from enrichment plants) several orders of magnitude more efficiently than thermal-spectrum gas reactors with once-through fuel cycles. Furthermore, through the combination of a fast neutron spectrum and full recycle of actinides, GFRs minimize the production of long-lived radioactive waste isotopes, and can be designed for management of minor-actinides in spent fuel. Interest for the GFR is high in GIF member countries France and Japan.

In FY 2004, research and development for the GFR was conducted as follows:

- Accident scenarios for both the reference and alternate concepts were analyzed to verify the reactor's ability to shutdown passively through negative reactivity coefficients. This activity included the optimization of safety systems for decay-heat removal (short, intermediate, and long-term), including physics and thermal-hydraulic analyses for the reference and optional systems. In addition, reactor control issues were identified and analyzed for operational modes and accident scenarios.

- Screening and testing of candidate high-temperature materials, including both refractory ceramics and refractory or special metals were initiated.

- Supercritical-carbon-dioxide corrosion studies of candidate materials, including coolant chemistry were completed. Screening of candidate materials for in-core and ex-core service was also conducted based on performance at high pressure and medium temperatures.

In FY 2005, research and development activities for the GFR are focusing on the following activities:

- Continuing material characterization and fabrication, including the preparation of candidate materials for irradiation testing in FY 2006.

- Performing preliminary pre-conceptual design of the GFR core and safety systems.

- Continuing the analysis of off-normal accident analysis to optimize safety systems and support the overall reactor design.

In FY 2006, research and development activities for the GFR will focus on the following:

- Fabricate structural material test samples and initiate irradiation testing. Initiate thermal-hydraulic experiments using the Matched-Index-Refraction flow test system developed by the INL.

- Continue to perform preliminary concept design of the core and safety systems based on the optimized safety systems studies completed in FY 2005.

Supercritical-Water-Cooled Reactor: The Supercritical-Water-Cooled Reactor (SCWR) concept is a high-temperature, high-pressure water-cooled reactor that operates above the thermodynamic critical point of water. The system may have a thermal or fast neutron spectrum depending upon the core design. The focus in the United States will be on the thermal-spectrum version. The SCWR holds the potential for significant advantages compared to existing water-cooled reactors. The advantages are due to greater thermal efficiency; lower coolant mass flow rate per unit core thermal power; elimination of discontinuous heat transfer regimes within the core, and the elimination of steam dryers, steam separators, re-circulation pumps, as well as steam generators. Therefore, the SCWR will be a simpler plant with fewer major components and better economics. There is strong international interest in the SCWR within the Generation IV International Forum from Japan, Korea, and Canada.

In FY 2004, research and development was conducted as follows:

- A SCWR materials testing research and development plan was devised.

- A coolant chemistry-control strategy was developed. Analysis was conducted of existing light-water reactor and supercritical fossil plant coolant chemistry control strategies and their applicability to the SCWR system was evaluated.

In FY 2005, SCWR research and development focuses on the following activities:

- Complete the design of a test section to perform supercritical-water heat transfer studies in an existing supercritical-water facility (the Benson loop in Erlangen, Germany).

- Complete the concept design of the containment and safety systems.

In FY 2006, SCWR research and development will:

- Establish experimental capability for measuring corrosion in supercritical-water loops and improve the characterization of test variables like oxygen, conductivity and pH. The supported experiments will develop corrosion rates of candidate materials under various prototypical temperature, oxygen, and conductivity conditions.

(dollars in thousands)

FY 2004	FY 2005	FY 2006

- Design laboratory-scale, multi-sample, stress-corrosion cracking, supercritical-water loop experiments for investigating candidate materials. These experiments are required to understand the susceptibility of candidate materials to stress-corrosion cracking.

- Design a high-pressure facility for critical-flow experiments at critical conditions. Data on basic critical flow and heat transfer are lacking for prototypical supercritical-water conditions and are needed to evaluate the safety and performance characteristics of candidate materials.

Crosscutting Research and Development: Crosscutting research activities are being conducted where results will have applicability to two or more of the Generation IV concepts.

In FY 2004, the following crosscutting research activities were conducted:

- Design and Evaluations - established the methodology for measuring proliferation resistance and physical protection of Generation IV reactor and fuel cycle systems, and developed the methodology to be used in evaluating the economics of Generation IV systems.

- Materials - prepared an integrated program plan for the qualification and development of advanced materials for use in Generation IV reactors.

- Energy Conversion - prepared a conceptual design of a supercritical-carbon-dioxide cycle that would provide cycle efficiencies of 40% or more with a coolant inlet temperature above 500 ºC.

- Regulatory - supported the Nuclear Regulatory Commission's development of a framework for risk informed licensing. Such a licensing framework may be applied to all of the Generation IV concepts in the future.

In FY 2005, the following crosscutting research activities are being conducted:

- Design and Evaluation – validating computer models for the use of design and safety analysis applications; developing methodology for evaluating the economics of Generation IV systems including associated hydrogen production; developing methods for evaluating proliferation resistance and physical protection metrics and developing a framework for computerization of the methodology; and participating in Generation IV International Forum activities.

- Materials – initiating mechanical tests and irradiation tests on commercially available and advanced materials; coordinating the specific materials needs of each reactor type; coordinating the specific materials needs of power conversion systems; initiating the development of a comprehensive irradiation-effects materials database for materials needed for radiation service; and initiating the development of a comprehensive high-temperature materials properties database to support the design, use, and codification of materials needed.

- Energy Conversion – developing a preliminary system and turbo machinery design for a 300 megawatts electric supercritical-carbon-dioxide commercial cycle; and developing a preliminary design for a scaled supercritical-carbon-dioxide demonstration experiment.

(dollars in thousands)

FY 2004	FY 2005	FY 2006

In FY 2006, the following crosscutting research activities will be conducted:

- Design and Evaluation - modify and validate computer models for the use in design and safety analyses; validate the methodology for evaluating the economics of hydrogen production with Generation IV systems; validate methods for evaluating proliferation resistance and physical protection metrics, and complete the development of a computer program to apply the methodology to Generation IV systems; and ongoing U.S. participation in GIF activities.

- Materials - continue mechanical scoping tests of high-temperature materials; initiate the development of the rules for the use of low-temperature design criteria for reactor pressure vessels in limited high-temperature service, initiate creep-fatigue tests and the development of a creep-fatigue damage models for modified 9Cr-1Mo steel and Alloy 617, and complete the design of facilities for low and high flux, high-temperature irradiations.

- Energy Conversion – develop the system and turbo-machinery design for a 300 megawatts electric supercritical-carbon-dioxide commercial cycle; and initiate the fabrication of components for a scaled supercritical-carbon-dioxide demonstration experiment.

International Nuclear Energy Research Initiative

(I-NERI)	**4,084**	**4,060**	**4,060**

In FY 2004, the program funded bilateral research projects with France, the Republic of Korea, and the Organization for Economic Cooperation and Development (OECD) Nuclear Energy Agency initiated in FY 2001 through FY 2003. Three projects initiated with France in FY 2001, in the areas of advanced reactor technology, advanced nuclear fuels and materials, were completed. The Department neared completion of bilateral agreements with the Republic of South Africa, Japan, and the United Kingdom. New projects initiated in FY 2004 with France, the Republic of Korea, Canada and the European Union were funded under specific research areas of the Generation IV Nuclear Energy Systems Initiative, Advanced Fuel Cycle Initiative, and Nuclear Hydrogen Initiative programs. The new approach to executing international, cost-shared research allows the Department to use all nuclear energy R&D programs as a basis for international, cost-shared R&D thereby significantly increasing the amount of research achievable otherwise.

In FY 2005, the Department initiated new collaborations with Japan and Brazil and continues to use its existing bilateral International Nuclear Energy Research Initiative agreements to conduct international cost-shared R&D. The budget request included base funding for existing projects awarded in FY 2003 and support for International Near Term Deployment Systems (INTD) work identified by the GIF that is relevant to U.S. technology needs.

In FY 2006, the Department plans to use the requested funding to initiate new INTD research and development projects under the bilateral agreements with GIF member countries.

(dollars in thousands)

	FY 2004	FY 2005	FY 2006
Small Business Innovative Research and Small Business Technology Transfer Programs	**0**	**870**	**1,187**
Total, Generation IV Nuclear Energy Systems Initiative	**26,981**	**39,683**	**45,000**

Explanation of Funding Changes

	FY 2006 vs. FY 2005 ($000)
Generation IV R&D	
As a result of R&D successes in FY 2004 and FY 2005, the FY 2006 budget request includes an increase of $5,000,000 to expand R&D efforts required to establish the technical viability of Generation IV technology	+5,000
Small Business Innovative Research and Small Business Technology Transfer Programs	
The increase of $317,000 is due to increased funding for research and development activities.	+317
Total Funding Change, Generation IV Nuclear Energy Systems Initiative	**+5,317**

Nuclear Hydrogen Initiative

Funding Schedule by Activity

(dollars in thousands)

	FY 2004	FY 2005	FY 2006	$ Change	% Change
Nuclear Hydrogen Initiative					
Nuclear Hydrogen Initiative	6,201	8,679	19,440	+10,761	+124.0%
Small Business Innovative Research/Small Business Technology Transfer Program	0	250	560	+310	+124.0%
Total, Nuclear Hydrogen Initiative	6,201	8,929	20,000	+11,071	+124.0%

Description

The Nuclear Hydrogen Initiative (NHI) will conduct research and development on enabling technologies, demonstrate nuclear-based hydrogen production technologies, and study potential hydrogen production schemes to support the President's vision for a future Hydrogen economy. The objective of the Nuclear Hydrogen Initiative is to develop technologies that will apply heat available from advanced nuclear energy systems to produce hydrogen at a cost competitive with other alternative transportation fuels.

Benefits

With increased international concern about global climate change and greenhouse gases, there is an ongoing global effort to reduce carbon dioxide emissions and to develop carbon-free fuels. Currently, the most promising non-carbon fuel is hydrogen. Hydrogen is the most abundant element and makes up about 90 percent of the universe by weight. On earth, most hydrogen is bound up in molecules like water and methane. Hydrogen can be produced by splitting water into hydrogen and oxygen. However, the economic feasibility of large-scale production of hydrogen from water is as yet unproven.

Hydrogen offers significant promise as a future domestic energy source, particularly for the transportation sector. Hydrogen can be combusted in a traditional internal combustion engine, or can produce electricity in a fuel cell. Significant progress in hydrogen combustion engines and fuel cells is bringing the day closer when transportation using hydrogen fuel will be a reality. Before hydrogen can become a significant part of the Nation's energy infrastructure, the cost associated with the production, storage, and delivery of hydrogen must be reduced considerably.

Currently, the only economical, large-scale method of hydrogen production involves the conversion of methane into hydrogen through a steam reforming process. This process produces ten kilograms of greenhouse gases for every kilogram of hydrogen, defeating a primary advantage of using hydrogen—its environmental benefits. Another existing method, electrolysis, converts water into hydrogen using electricity. Electrolysis is typically used for small production quantities but is inherently less efficient because electricity must first be produced to run the equipment used to convert the water into hydrogen. Additionally, the environmental benefits of electrolysis are negated

unless a non-emitting technology, such as nuclear or renewable energy, is used to produce the electricity.

The NHI is part of the Department's Hydrogen Program, which is made up of programs within the Offices of Nuclear Energy, Science and Technology (NE), Energy Efficiency and Renewable Energy (EE), Fossil Energy (FE), and Science (SC). The Department created the "Hydrogen Posture Plan" (http://www.eere.energy.gov/hydrogenandfuelcells/posture_plan04.html) to describe its plan for successfully integrating and implementing technology research, development, and demonstration activities needed to cost-effectively produce, store, and distribute hydrogen for use in fuel cell vehicles and electricity generation. The Posture Plan describes the interface of the Department's hydrogen activities with those of other federal agencies. The Department pursues an integrated approach to hydrogen R&D, with EE, NE, and SC conducting coordinated research activities related to thermochemical hydrogen production cycles. NE has primary responsibility for processes that operate across a range of temperatures for the various advanced reactors being researched by the Generation IV Nuclear Energy Systems Initiative.

NE has built upon the "Hydrogen Posture Plan" and the "National Hydrogen Energy Roadmap" (http://www.eere.energy.gov/hydrogenandfuelcells/pdfs/national_h2_roadmap.pdf) released by the Secretary of Energy in November 2002, to develop the "Nuclear Hydrogen R&D Plan" (http://www.nuclear.gov). The "Nuclear Hydrogen R&D Plan" was developed by experts in hydrogen generation and nuclear technology to define the R&D required to develop an integrated nuclear hydrogen production plant. The plan presents the approach that the NHI program will use to achieve its overall objective, including priorities and technology selection, development and potentially demonstration.

The "Nuclear Hydrogen R&D" Plan describes major research areas required to support the development of these technologies, such as high-temperature materials, separation membranes, advanced heat exchangers and supporting systems. Based on their level of maturity, the sulfur family of cycles (sulfur-iodine, hybrid sulfur, sulfur-bromine), and high-temperature electrolysis are considered "baseline" processes, and have the highest R&D priority. The "Nuclear Hydrogen R&D Plan" also outlines a robust strategy that provides for the assessment of several alternative cycles have been identified as deserving of further study, such as the calcium-bromine cycle (which might be applicable to liquid metal fast reactor systems in the longer-term future). As some alternative hydrogen production technologies may also be pursued by other DOE offices, all such work is coordinated carefully to avoid duplication of effort. The program is conducting R&D on these processes to determine their feasibility as applied to nuclear systems. The alternative cycles involve significantly more technical risk, but their lower temperature requirements and, in some cases, reduced complexity, make them worthy of continued research—particularly since they could provide a pathway for future fast reactor systems to produce hydrogen on an economic bases.

While the Department believes that fast reactors may have a long-term future in the United States, there is a consensus in the international community and in the U.S. private sector that advanced gas-cooled reactors have the greatest potential among all Generation IV technologies to be commercialized in the foreseeable future. These systems, because of the high temperatures they produce, are projected to have considerable capability to produce electricity at very high levels of efficiency. Another capability related to the high-temperature heat that can be derived from these systems is their ability to drive high-temperature hydrogen production processes.

The NHI is sponsoring research within the university research community. For example, the Department is working with the University of Nevada, Las Vegas (UNLV), to perform research and development on candidate heat exchanger designs. As a result of significant research needs in this area, UNLV's scope has increased to include much of the complimentary materials development activities. UNLV actively involves other universities, industry, and national laboratories.

Detailed Justification

(dollars in thousands)

	FY 2004	FY 2005	FY 2006
Nuclear Hydrogen Initiative	**6,201**	**8,679**	**19,440**

The program will conduct research and development on processes that operate across a range of temperatures for various advanced reactors being researched by the Generation IV Nuclear Energy Systems Initiative. Much of the program's focus is vested in the most promising technologies—the sulfur-iodine (S-I) thermochemical cycle and high-temperature electrolysis. However, alternative processes with significant potential, such as the calcium-bromine and copper-chlorine cycles, continue to be evaluated.

The S-I thermochemical cycle is a series of chemical reactions that converts water to hydrogen and oxygen. This process offers the potential for high-efficiency hydrogen production at large-scale production rates, but has several technical issues that must be resolved to make the process technically and economically feasible. High-temperature electrolysis produces hydrogen from steam using electricity. This method has the potential for higher efficiencies than standard electrolysis and can operate across a range of temperatures. To better leverage this research and increase the probability of achieving the program objective, the hybrid sulfur (HS) cycle will be investigated, which is similar to the S-I cycle, but replaces a challenging chemical step with an electrolytic step. In addition, research on alternative processes, which operate over a range of temperatures, will include system analyses based on a consistent flowsheet methodology. The supporting technologies required at these temperatures and the overall objective to improve process performance will involve overcoming many technical challenges, including the development of high-temperature materials, advanced heat exchanger technologies and separation membranes.

In FY 2004, the Department:

- Initiated laboratory-scale research, experimental design, and fabrication on the baseline hydrogen production technologies - the S-I thermochemical cycle and high-temperature electrolysis (HTE).
- Completed initial conceptual design and the preliminary laboratory-scale demonstration plan for HS cycle.
- Completed the flowsheet analysis of process options and the preliminary laboratory-scale demonstration plan for Ca-Br cycle.
- Initiated screening and testing of component materials to determine compatibility with process working fluids.
- Initiated analysis of balance-of-plant issues for the design of the hydrogen production plants, such as establishing system interface conditions including temperatures, pressures, and flow

rates; and identifying and addressing reagent inventory issues.
- Continued research to determine candidate high-temperature process heat exchanger concepts and materials.
- Initiated conceptual design of two pilot-scale experiments (200 kilowatt HTE experiment and a 500 kilowatt S-I thermochemical process experiment).
- Completed an initial assessment of membranes and catalysts for thermochemical cycles to determine where process improvements can be made.
- Established a consistent analysis methodology to perform thermodynamic and flowsheet analysis for baseline and alternative thermochemical cycles. Completed flowsheet analysis of the S-I cycle and one alternative cycle.

In FY 2005, the Department will:
- Continue laboratory-scale research, experimental design, and fabrication on S-I and HTE hydrogen production technologies.
- Begin targeted laboratory-scale research, engineering assessments, and experimental design for alternative thermochemical cycles.
- Continue screening and testing of component materials to determine compatibility with process working fluids.
- Continue research on candidate high-temperature process heat exchanger concepts and materials for baseline technologies; initiate engineering design of selected heat exchanger designs to be tested before pilot and engineering-scale technology experiment operations; conduct thermal hydraulic and structural analysis of heat exchanger concepts for use with alternative hydrogen production technologies.
- Complete conceptual design of the pilot-scale experiments (200 kilowatt HTE experiment and the 500 kilowatt S-I thermochemical process experiment).
- Continue flowsheet analysis of alternative cycles.

In FY 2006, the Department will:
- Complete fabrication of heat exchangers for the S-I cycle and the HTE laboratory-scale experiments.
- Operate the S-I cycle chemical component reaction sections individually and initiate assembly in preparation for integrated laboratory-scale system operation in FY 2007.
- Complete long-duration and transient testing of HTE cell stacks that incorporate various cell materials and configuration options.
- Construct modular arrays of HTE cell stacks for integrated laboratory-scale operation in FY 2007.
- Complete thermal optimization and characterization of the S-I and HTE laboratory-scale experiments.
- Investigate the viability of the Ca-Br thermochemical process including a technical solution to the decomposition of hydrogen bromide.
- Complete flowsheets, economic analyses, and system designs for laboratory-scale experiments of high-potential alternative thermochemical cycles.
- Initiate preliminary design of pilot-scale experiments (200 kilowatt HTE experiments and the 500 kilowatt S-I thermochemical process experiment) to be completed in FY 2007.

(dollars in thousands)

FY 2004	FY 2005	FY 2006

- Begin National Environmental Policy Act (NEPA) documentation to support hydrogen production.
- Complete assessment of codes and standards applicable to a hydrogen production facility coupled to a nuclear reactor.

Small Business Innovative Research and Small Business Technology Transfer Programs	**0**	**250**	**560**
Total, Nuclear Hydrogen Initiative	**6,201**	**8,929**	**20,000**

Explanation of Funding Changes

	FY 2006 vs. FY 2005 ($000)
Nuclear Hydrogen Initiative	
The Nuclear Hydrogen Initiative (NHI) activities support the milestones identified in the "DOE Hydrogen Posture Plan" and the "Nuclear Hydrogen R&D Plan" (RDIC 1a – President's Hydrogen Initiative). In FY 2005, the program will evaluate the performance of stacks of cells to achieve higher hydrogen production rates. In FY 2006, the program will proceed with the plan to test cell stacks for long-duration and transient operation. The FY 2006 budget request includes an increase of $10,761,000 to support enhanced development of both the S-I thermochemical and high-temperature electrolysis hydrogen production methods as well as alternative hydrogen production methods to determine process viability	+10,761
Small Business Innovative Research and Small Business Technology Transfer Programs	
The increase of $310,000 is due to the increased funding for research and development activities	+ 310
Total Funding Change, Nuclear Hydrogen Initiative	**+11,071**

Advanced Fuel Cycle Initiative

Funding Schedule by Activity

(dollars in thousands)

	FY 2004	FY 2005	FY 2006	$ Change	% Change
Advanced Fuel Cycle Initiative					
Separations Technology Development	32,703	26,456	29,088	+2,632	+9.9%
Advanced Fuels Development	15,517	12,151	19,250	+7,099	+58.4%
Transmutation Engineering	8,675	18,834	10,000	-8,834	-46.9%
Systems Analysis	4,330	4,736	5,000	+264	+5.6%
Transmutation Education	4,525	4,285	5,000	+715	+16.7%
Small Business Innovative Research and Small Business Technology Transfer Programs	0	1,000	1,662	+662	+66.2%
Total, Advanced Fuel Cycle Initiative	65,750	67,462	70,000	+2,538	+3.8%

Description

The mission of the Advanced Fuel Cycle Initiative (AFCI) is to develop and demonstrate technologies that will enable the United States and other advanced countries to implement an improved, long-term nuclear fuel cycle that provides substantial environmental, nonproliferation, and economic advantages over the current once-through fuel cycle. AFCI is designed to develop these new technologies so that they may be deployed to support the operation of current nuclear power plants, Generation III+ light water reactors, and Generation IV advanced reactors in order to achieve a significant reduction in the amount of high-level radioactive waste requiring geologic disposal; to reduce significantly accumulated plutonium in civilian spent fuel; and to extract more useful energy from nuclear fuel.

Under all scenarios, the Nation will need to establish a permanent geological repository to deal with the radioactive wastes resulting from the operation of nuclear power plants. However, as highlighted in a recent report by the independent experts of the Nuclear Energy Research Advisory Committee (NERAC), any substantial growth projected in the use of nuclear energy in the United States (such as is called for in the "National Energy Policy") will require the construction of additional geologic repositories to address the nuclear waste generated over time. Conservative scenarios that assume the replacement of existing nuclear plants by new nuclear capacity are projected to require one-to-three additional repositories by 2100.

AFCI provides an alternative to building multiple "Yucca Mountains" while still supporting an expanding role for nuclear power in the United States. AFCI's primary near-term goal is to develop advanced, proliferation-resistant fuel cycle technologies in order to inform a recommendation by the Secretary of Energy regarding the need for additional geologic repositories. Current legislation requires the Secretary to make a recommendation to Congress regarding the need for a second repository as early as January 1, 2007, but before January 1, 2010.

In the longer term, AFCI's development of a system involving spent-fuel partitioning, recycling of actinides and other long-lived radioactive components in thermal-spectrum reactors, and transmutation of nuclear materials using fast-spectrum technologies could result in a de facto fifty-fold increase in the capacity of the planned Yucca Mountain repository. This de facto increase would come from the destruction of actinides that generate the heat that limits repository capacity. The capacity increase would be more than enough to accommodate all the spent fuel generated in the U.S. this century from any conceivable nuclear energy deployment scenario.

Benefits

Of the challenges that must be addressed to enable a future expansion in the use of nuclear energy in the United States and worldwide, none is more important or more difficult than that of dealing effectively with spent nuclear fuel. Compared to other industrial waste, the spent nuclear fuel generated during the production of electricity is relatively small in quantity. However, it is highly toxic for many thousands of years, and its disposal requires that many political, societal, technical, and regulatory issues be addressed. For many years, several countries around the world have pursued advanced technologies that could treat and transmute spent nuclear fuel from nuclear power plants. These technologies have the potential to dramatically reduce the quantity and toxicity of waste requiring geologic disposal. Over the last four years, the United States has joined this international effort and found considerable merit in this area of advanced research.

While these technologies are clearly not an alternative to a geologic repository, they could provide a means to optimize the first U.S. repository and reduce the technical need for additional repositories. These technologies could also provide other important benefits such as enhancing national security by reducing proliferation risk through the reduction of inventories of commercially-generated plutonium (which is contained in all commercial spent fuel) and enhancing national energy security by recovering the significant energy value contained in spent nuclear fuel. (The 44,000 metric tonnes of spent nuclear fuel currently stored at nuclear power plant sites across the country contain the energy equivalent of over 6 billion barrels of oil, or about two full years of U.S. oil imports.) Through the research conducted by the Department and its international partners, sufficient evidence exists to warrant cautious optimism that the benefits of these technologies can be realized in a proliferation-resistant manner.

Over the long term, the AFCI program will demonstrate technologies that could reduce the volume and initial heat generation of high-level repository wastes. The AFCI program, in cooperation with the Department's Office of Civilian Radioactive Waste Management (RW) and international partners, will develop proliferation-resistant separations processes and advanced fuels for application to current light water reactor systems and advanced light water and gas-cooled reactor systems to enable the energy value of these materials to be recovered, while destroying significant quantities of plutonium. This work provides the opportunity to optimize use of the Nation's first repository and reduces the technical need for additional repositories.

For the longer term, the advanced technologies emerging from the AFCI program will build upon the benefits described above by enabling the destruction of minor actinides, greatly reducing the long-term radiotoxicity and long-term heat load of high-level waste sent to a geologic repository. This will be accomplished through the development of Generation IV fast reactor fuel cycle technologies and, possibly, accelerator-driven systems (ADS). Implementation of these technologies in conjunction with those being developed for application to thermal reactor systems will significantly delay or eliminate the

need for an additional repository. Working closely in an integrated manner with the Department's Generation IV Nuclear Energy Systems Initiative, the AFCI program will develop advanced, proliferation-resistant fuels and fuel cycle technologies needed for Generation IV systems.

Based on research conducted to date, the following benefits are attainable through the AFCI program:

- Reduce Spent Fuel Volume: Develop proliferation-resistant technologies to significantly reduce the absolute volume of high-level nuclear waste requiring geologic disposal and lower the cost of its disposal;
- Separate Long-Lived, Highly Radiotoxic Elements (i.e., actinides such as plutonium and americium): Develop by approximately 2030, advanced, proliferation-resistant spent nuclear fuel treatment and transmutation technologies for Generation IV fast reactor systems that will significantly reduce its volume and heat generation, and create waste forms sufficiently clean of long-lived, highly toxic species to reduce the time it takes for the radiotoxicity of the waste to decay to that of the original uranium ore from 300,000 years to less than 1,000 years; and
- Reclaim Spent Fuel's Valuable Energy While Reducing Proliferation Risk from the Plutonium in Spent Fuel: Develop advanced, proliferation-resistant nuclear fuels that will enable the consumption of plutonium in existing light water reactors (LWR) or Generation IV reactors that may be available in the future. In addition, develop ultra-high burn-up fuels in order to extract more energy from fuel during its initial cycle and improve spent fuel management and storage. For example, very high burn-ups are possible in high-temperature gas reactors, such that recycling of spent nuclear fuel is unnecessary to optimize consumption of the fuel and minimize the radiotoxicity of spent fuel.

This work can realize the vision anticipated by the "National Energy Policy" to explore advanced technologies to deal with spent nuclear fuel in cooperation with our international partners. The AFCI program implements the recommendations of the "National Energy Policy" with respect to reconsideration of next generation fuel cycle technologies, specifically:

> "....United States should reexamine its policies to allow for research, development and deployment of fuel conditioning methods (such as pyroprocessing) that reduce waste streams and enhance proliferation resistance. In doing so, the United States will continue to discourage the accumulation of separated plutonium, worldwide."
>
> "The United States should also consider technologies, in collaboration with international partners with highly developed fuel cycles and a record of close cooperation, to develop reprocessing and fuel treatment technologies that are cleaner, more efficient, less waste intensive, and more proliferation resistant."

The Department will continue to emphasize joint collaborative activities in spent fuel treatment research, design and development. Considerable expertise in these technologies has been developed internationally, and the potential for significant cooperation and collaboration is very high. The Department is currently collaborating with France, Switzerland, the European Union, Canada, Japan and the Republic of Korea in separations, fuels, transmutation engineering and test facilities.

The AFCI program is comprised of five main research elements: Separations Technology Development; Advanced Fuels Development; Transmutation Engineering; Systems Analysis, and Transmutation Education. Each element is integrated into an overall effort guided by detailed research plans that have been independently reviewed by NERAC.

Separations Technology Development

The AFCI program is investigating technologies in two primary separations areas – advanced aqueous-based processing and pyroprocessing. Many aqueous-based approaches to treat spent nuclear fuel exist. The Uranium Extraction Plus (UREX+) method is an advanced aqueous process with significant potential for meeting proliferation-resistant separations objectives while minimizing the waste generation historically associated with aqueous separations technologies. While UREX+ has great potential to address the spent fuel challenge associated with today's light water reactors, pyroprocessing is potentially better suited to address the needs of Generation IV fast reactor fuels.

Experiments completed by the AFCI program have proven the advanced, aqueous-based Uranium Extraction (UREX) technology to be capable of removing uranium from spent fuel at such a high level of purity that we expect it to be sufficiently free of high-level radioactive contaminants to allow it to be disposed of as low-level waste or reused as reactor fuel. These laboratory-scale tests have proven uranium separation at purity levels of 99.999 percent. If spent fuel were processed in this manner, the volume of high-level waste requiring disposal in a geologic repository could be significantly reduced, potentially lowering the cost of storing the remaining high-level waste.

UREX+ is an extension of the UREX technology and is a key element of the AFCI program. Additional research is underway to evaluate aqueous chemical treatment methods to separate selected actinide and fission product isotopes from the UREX stream after the uranium has been removed. For example, UREX+ would provide mixtures of plutonium and selected minor actinides for preparing proliferation-resistant transmutation fuels. Long-lived fission products, iodine-129 and technicium-99, which are major contributors to the long-term radiotoxicity of spent fuel, could be separated for long-term storage or incorporated into advanced fuels for next generation reactors.

Pyroprocessing is a highly efficient, proliferation-resistant non-aqueous approach to separate the actinides in spent fuel from fission products. The AFCI pyroprocessing activities support the reduction of the radiotoxicity of nuclear waste through the transmutation of minor actinides in future Generation IV fast spectrum reactors or in dedicated transmuter devices. In addition, these activities provide the means for closure of the fuel cycle for Generation IV fast reactors.

The Department is also conducting research in other advanced separation technologies, *e.g.* Actinide Crystallization Process (ACP), to remove the uranium from the spent fuel. In addition, other advanced techniques have been identified that may improve the overall economic viability as well as enhance the proliferation resistance of closed fuel cycles. Examples of these technologies include:

- Voloxidation: After uranium dioxide spent fuel is exposed by decladding or puncturing, the fuel is treated with high temperature oxygen or oxygen/steam mixtures which convert uranium dioxide to uranium trioxide or intermediate oxide mixtures. Perforated cladding may be split but in any case, the resulting fuel is much more soluble in subsequent reagents compared with the dense, inert dioxide;

- Fission Product Volatility: Besides improved solubility, another potential benefit of oxygen pretreatment of uranium dioxide fuels is the removal of several volatile fission products such as chemically-inert xenon and krypton plus iodine and cesium. Research on removal of volatile radionuclides and their selective collection could greatly simplify later separation steps;

- Dissolution in Basic Media: Aqueous separations processes throughout the world use acidic dissolution as the first step. Preliminary experiments have indicated that carbonate solutions may replace acids under some conditions with a potential for subsequent improved separations including crystallization.

Advanced Fuels Development

The AFCI fuels development activity is focused on developing proliferation-resistant light water reactor and gas-cooled (thermal) reactor fuels that will enable the consumption of significant quantities of plutonium from accumulated spent fuel, simultaneously extracting more useful energy from the spent fuel materials. A series of advanced oxide fuel tests containing plutonium, neptunium and americium are in progress that will demonstrate the ability to fabricate the fuels and transmute the higher actinides in thermal reactors. Ultra-high burnup fuels are also under investigation that have the potential to extract more energy from the fuel and reduce the amount of high-level waste requiring repository disposal.

The fuels program is also developing advanced fuels containing higher actinides (plutonium, neptunium, americium, and curium) for transmutation in Generation IV fast reactor systems. Transmutation of the actinides in these advanced reactor fuels would significantly reduce the actinide inventory in the spent fuel, thereby reducing the radiotoxicity and long-term heat load in a geologic repository. A series of tests are in progress using the Advanced Test Reactor (ATR) in Idaho to irradiate metal, nitride and dispersion transmutation fuels. Data from the initial metal and nitride fuel tests conducted in FY 2004 are being evaluated now to prepare documentation needed to insert similar test articles into a fast reactor (the Phenix reactor in France) in FY 2007 to determine behavior of these fuels in a fast neutron spectrum. Because the Phenix reactor is scheduled to be permanently deactivated in 2008, the Department is pursuing establishment of a Gas Test Loop to be fitted into the ATR.

Transmutation Engineering

Transmutation is a process by which certain long-lived radioactive species are converted to short-lived and lower radiotoxicity species. Transmutation can convert the most significant long-lived species in spent nuclear fuel such that the most radiotoxic materials requiring geologic disposal will decay in a few centuries instead of hundreds of millennia.

AFCI transmutation engineering activities are developing the engineering for the transmutation of minor actinides and long-lived fission products from spent fuel. This includes computer programs, experimental measurements, benchmark calculations, maintenance and updating of nuclear cross-section data, nuclear physics data and codes, coolants and corrosion, structural materials, and pursuit of international collaborations to support technology decisions on reactor-and accelerator-assisted transmutation systems.

In FY 2005 a Materials Test Station (MTS) at the Los Alamos Neutron Science Center is being designed to fire high energy protons from the existing linear accelerator into a spallation target to create a large fast neutron flux for irradiating fuel and material targets to learn more about their behavior in a fast reactor. The University of Nevada – Las Vegas (UNLV) and the Idaho Accelerator Center at Idaho State University are also actively engaged in experiments on lead alloy coolants and targets in accelerator-based systems with potential application to fast reactor systems as well.

Through international cooperation, the AFCI program remains involved in Accelerator Driven System (ADS) research and development activities performed overseas. AFCI is cooperating with France, Switzerland, and the European Union on an accelerator-driven system spallation target test called MEGAPIE (Megawatt Accelerator Proton Irradiation Experiment) and a reactor-accelerator coupling experiment called TRADE (TRIGA Reactor Accelerator Driven Experiment), and is planning additional collaborations with Japan and the Republic of Korea. These activities will help inform future decisions on the need for an ADS to supplement fast reactors in the destruction of minor actinides.

Systems Analysis

The primary function of the AFCI systems analysis activity is to develop and apply evaluation tools to formulate, assess, and guide program activities to meet programmatic goals and objectives. The focus of this activity is the evaluation and eventual down selection of the most promising spent fuel treatment technologies, fuels technologies, and advanced fuel cycle deployment strategies in light of the steadily-increasing knowledge acquired from parallel AFCI and Generation IV research and development activities. These activities are aimed at integrating the results of the AFCI and Generation IV research programs and the programs themselves. Additionally, the systems analysis activity will identify optimal systems to reduce the burden on the geologic repository by removing the uranium and major heat-generating components of spent nuclear fuel from the repository, and optimizing the destruction of actinides to reduce the radiotoxicity of the waste from 300,000 years to less than 1,000 years. Cost-benefit, proliferation resistance, safety and sustainability analyses will be performed for each promising option. The systems analysis activity, by determining the optimum mix of facilities and systems, will enable the Department to effectively prioritize program research and development.

Transmutation Education

Transmutation Education activities include the successful university fellowship program established to support the development of new U.S. scientists and engineers studying science and technology issues related to transmutation and advanced nuclear fuel cycle systems. Managed by the University Research Alliance, the ongoing AFCI Fellowships program will augment its current master degree fellowships with the award of Ph.D. fellowships in FY 2006. AFCI will continue to support the Nuclear Energy Research Initiative through which competitively selected university researchers and students collaborate with national laboratories in AFCI R&D activities. Finally, AFCI will continue to support student research activities directly related to the program at UNLV and the Idaho Accelerator Center.

Detailed Justification

(dollars in thousands)

	FY 2004	FY 2005	FY 2006
Separations Technology Development	**32,703**	**26,456**	**29,088**

The primary goal of the separations activities is to develop and demonstrate advanced aqueous and pyrochemical separations technologies and to inform a recommendation by the Secretary of Energy as early as 2007 on the technical need for a second repository.

- **Proliferation-Resistant Fuel Treatment Experiments** **7,650** **8,456** **11,088**

  In FY 2004, the Department continued laboratory-scale hot testing of the UREX+ processes. In addition, the Department performed a scoping study of a commercial spent fuel processing plant, including cost and schedule estimates.

  In FY 2005, the Department is continuing laboratory-scale hot testing of advanced aqueous processes at INL, ANL and ORNL, (including plutonium/neptunium, cesium/strontium and americium/curium extraction) that will provide additional data for developing an optimized UREX+ flowsheet, and provide further verification of the AMUSE computer code (used to predict performance of various flowsheets and reagent flows). Further work is being performed on development of adequate dry storage and waste forms for the separated products, helping to reach the objective of only dry product streams of minimum volume.

  In FY 2006, final hot tests at a laboratory scale of the various UREX+ flowsheet variations will be carried out, to allow a final selection of the optimum flowsheet in FY 2007. The Department will also begin the scale-up of hot laboratory testing of UREX+ to an engineering scale experiment. The scale-up will provide for cold testing of individual advanced unit operations. Cold testing of advanced dissolvers will begin, providing the potential for large increases in head-end throughput. Scaled-up precipitators will be cold-tested using surrogate materials, and calciners approaching engineering scale will be evaluated. Waste qualification experiments and data analysis will be conducted on spent fuel processing to provide data to the Office of Civilian Radioactive Waste Management. A pre-conceptual design for an advanced fuel cycle research laboratory at the Idaho National Laboratory (INL) will be developed. A collaboration will be pursued with the French Atomic Energy Commission, Commissariat à l'Energie Atomique (CEA), to conduct a group actinide extraction test (GANEX) at the CEA Atalante facility.

- **Generation IV Fuel Treatment Process Development** **25,053** **18,000** **18,000**

  In FY 2004, the Department continued electrorefiner operations in support of pyroprocessing development. Waste qualification experiments and data analysis were continued. The Department also supported engineering scale-up design on a prototype ceramic waste furnace to handle the output from the electrorefiner operations. As reflected in the "Report on the Preferred Treatment Plan for EBR-II Sodium-Bonded Spent Nuclear Fuel" (October 2003), the program focused on treating highly-enriched, sodium-bonded driver fuel while investigating alternatives to more cost-effective technologies for processing sodium-bonded blanket fuel.

(dollars in thousands)

FY 2004	FY 2005	FY 2006

In FY 2005, advanced alternative separations experiments applying the Actinide Crystallization Process (ACP) technology are being investigated. The Department continues development and testing of methods to separate lanthanides from trivalent actinides and americium from curium. The feasibility of ACP will be tested with cold spent fuel surrogates dissolved in nitric acid, and work will begin on the use of a carbonate-based crystallization process. Security systems for materials accountability within batch and continuous separations processes are under development. The Department is continuing pyrochemical treatment of EBR-II spent driver fuel and investigating more cost-effective alternative technologies for processing the blanket fuel. Based on experience in the treatment of EBR-II spent fuel, advanced pyrochemical process development is continuing in support of Generation IV fuel types including ceramic-ceramic and ceramic-metallic designs. These processes include molten salt dissolution and electrochemical oxidation-reduction steps.

In FY 2006, the Department will expand its research into alternative advanced separation technologies, specifically advanced crystallization process and ionic liquids. It will begin a series of advanced separations tests involving combined aqueous/pyrochemical hybrid processes which offer increased versatility compared with either aqueous or pyrochemical processes operated separately. Pyrochemical tests on the separation of cesium and strontium from molten salts will be initiated along with tests of the separation of individual and group transuranic elements, including americium/curium from other actinides and americium from curium. A new separations activity involving the use of continuous, countercurrent extraction systems based on molten salts and metals flowing in opposite directions through a multistage separations unit will also be explored. Development of high-throughput electrorefiners and metal waste forms will continue. This research could significantly improve the economics of pyrochemistry applied to Generation IV systems. The Department will also continue pyrochemical treatment of EBR-II spent driver fuel and investigate more cost-effective alternative technologies for processing the blanket fuel.

Advanced Fuels Development **15,517** **12,151** **19,250**

The AFCI fuels development effort will develop proliferation-resistant transmutation fuels for use in advanced fuel cycles for current LWRs, advanced LWRs, and gas-cooled reactors. It will develop ultra-high burn-up fuels for use in existing LWRs and also develop and demonstrate prototypic and transmutation fuels for Generation IV nuclear energy systems.

- **LWR Oxide Fuel Development and Testing** **3,739** **3,500** **7,000**

  In FY 2004, the Department performed irradiations in the Advanced Test Reactor (ATR) of the first LWR mixed-oxide transmutation test fuel and initiated its post irradiation examination (PIE)

  In FY 2005, the Department is completing the PIE of the first mixed-oxide transmutation test fuel, and preparing oxide and inert matrix test fuels for irradiation in FY 2006.

  In FY 2006, the Department will complete an inert matrix fuel irradiation test in the ATR. Irradiation of a higher burn-up LWR mixed-oxide transmutation fuel will be initiated. The Department will also investigate ultra-high burn-up fuels for use in LWRs in order to extract more energy from the fuel without recycling.

(dollars in thousands)

FY 2004	FY 2005	FY 2006

- **Generation IV Reactor Fuel Development and Testing** **11,778** **8,651** **12,250**

In FY 2004, the Department screened fuel options for next-generation reactor concepts and completed plans for irradiation testing and PIE of possible Generation IV fuel forms. In support of the PHENIX fast spectrum reactor irradiation tests, initial irradiation testing of metal and nitride actinide-bearing transmutation fuels in the ATR were performed. A low burn-up gas-cooled fast reactor dispersion fuel materials irradiation test was also completed. In support of the advanced gas reactor fuel development and qualification activities, coated particle fuel for the first fuel irradiation shakedown test was fabricated and the preliminary capsule and test train designs for the test were finalized.

In FY 2005, the Department is conducting post-irradiation examination (PIE) on the actinide-bearing metal and nitride fuel forms in support of the PHENIX test. In addition, high burn-up ATR irradiation tests containing metal and nitride actinide-bearing transmutation fuels and a high burn-up gas cooled fast reactor dispersion fuel test will be initiated. In support of the advanced gas reactor fuel development and qualification activities, the Department in FY 2005 will complete the fabrication of a multi-cell capsule for ATR irradiation tests and produce the fuel particle fuel test specimens for the first ATR irradiation test, scheduled in FY 2006. In addition, "deep-burn" fuel concepts for advanced gas-cooled reactors will be studied by AFCI program participants led by UNLV.

In FY 2006, the Department will complete and report on the analysis of results of the PIE of the advanced actinide-bearing fuels tests, initiate medium burn-up inert matrix fuel tests in the ATR and complete the medium burn-up gas cooled fast reactor dispersion fuel test. CERCER/CERMET fuels will be investigated as potentially promising dispersion fuels for the gas-cooled fast reactor. Commitments to the French Atomic Energy Commission, Commissariat à l'Energie Atomique (CEA) will be met, including the fabrication and shipment of all fast reactor transmutation fuel samples to the Institute for Transuranic Research (ITU) in Karlsruhe, Germany for the FUTURIX FTA test to be conducted in the French PHENIX fast reactor starting in FY 2007. Payment of the annual U.S. cost share of this U.S.-France cooperative program will be made. Collaboration with Japan will be initiated and transmutation fuel test samples prepared for irradiation in the JOYO fast test reactor in Japan. A trilateral collaboration with Japan and France will be initiated for a Global Actinide Cycle International Demonstration project on transmutation fuel irradiations, possibly leading to a full fuel assembly irradiation at the MONJU fast test reactor in Japan.

Transmutation Engineering **8,675** **18,834** **10,000**

Transmutation engineering provides critical research and development in the areas of physics, materials, and accelerator-driven systems (ADS).

In FY 2004, the Department continued analytical work on physics cross section measurements of selected minor actinides (americium-241 and -242) required for advanced transmutation reactor design

(dollars in thousands)

FY 2004	FY 2005	FY 2006

The Department also continued to engage in international collaborations with France, Switzerland, and the European Union on accelerator-driven system spallation target (MEGAPIE) tests and a reactor-accelerator coupling experiment (TRADE) to leverage transmutation program funds in the areas of transmutation materials and science, respectively.

In FY 2005, the Department is continuing transmutation physics measurement and analysis work to reduce uncertainties in minor actinide cross sections required for advanced transmutation reactor designs. This includes the completion of americium measurements initiated in FY 2004. In FY 2005, a Materials Test Station (MTS) at the Los Alamos Neutron Science Center is being designed for research into the behavior of transmutation systems and Generation IV reactor system fuel and structural materials in a large fast neutron flux. UNLV and the Idaho Accelerator Center (IAC) are also conducting experiments on lead alloy coolants and targets in accelerator-based systems with potential application to fast reactor systems as well. The Department continues to engage in international collaborations with France, Switzerland, and the European Union on accelerator-driven system spallation target (MEGAPIE) tests and a reactor-accelerator coupling experiment (TRADE).

In FY 2006, the Department will refine physics cross sections for advanced transmutation and Generation IV reactor designs and provide design support for advanced transmutation reactors. Additionally the Department will perform mechanical testing of structural material samples irradiated in the Fast Flux Test Facility, update the AFCI Materials Handbook and commence development of a lead-alloy coolant materials research capability at the Idaho National Laboratory. Transmutation engineering research will continue at UNLV and IAC. To further leverage research and development dollars, the Department will continue to engage in international collaborations with France, Switzerland, and the European Union on accelerator-driven system spallation target (MEGAPIE) tests and a reactor-accelerator coupling experiment (TRADE).

Systems Analysis	**4,330**	**4,736**	**5,000**

The systems analysis function develops and applies tools to formulate, assess, and steer program activities to meet programmatic goals and objectives. Activities include broad system studies, integrated nuclear fuel cycle system studies, transmutation system studies, and technology and facility assessments.

In FY 2004, the Department identified the nuclear fuel cycle technologies that offer the greatest promise for future use, developed the information necessary to conduct cost-benefit analyses for each of these technologies, and by determining the optimum mix of facilities and systems, prioritized program research and development. The results of this analysis are documented in the 2004 "AFCI Comparison Report" that the Department submitted to Congress in October 2004.

In FY 2005, the Department issued the 2004 "AFCI Comparison Report", which quantitatively identifies the respective advantages and disadvantages of the technologies explored by the program as well as the additional research and development knowledge gained during the program as well as the additional

(dollars in thousands)

research and development knowledge gained during the previous year. It will issue an annual update to the "AFCI Comparison Report". The Department will also issue a significant AFCI program report to Congress on quantitative goals for the program based on studies to identify the necessary capacities and time scales of implementation of advanced recycle technologies. Systems analysis is also evaluating cost/benefits of the program with regard to the development of proliferation-resistant, economic, sustainable nuclear energy for the remainder of the century and the extent to which technologies developed by the program can help optimize the use of the Yucca Mountain repository and indefinitely postpone the technical need for additional repositories.

In FY 2006, the Department will expand its cost-benefit analyses by conducting broad system studies, integrated nuclear fuel cycle system studies, transmutation system studies and technology and facility assessments. To support the preparation of a 2007-2010 Secretarial recommendation on the technical need for a second repository, the Department will complete analyses regarding the optimum mix of facilities and systems and associated R&D priorities. An update to the annual "AFCI Comparison Report" to Congress will be issued.

Transmutation Education	**4,525**	**4,285**	**5,000**

Transmutation education supports the development of new U.S. scientists and engineers needed to develop transmutation and advanced nuclear energy technologies through university fellowships and applied research.

In FY 2004, the Department awarded eight Masters fellowships to assure that new engineers will enter the field of transmutation science, continued and expanded directed university research to support advanced fuel cycles, and continued the university student research programs at UNLV and IAC.

In FY 2005, directed university research to support advanced fuel cycles is funded by the technical program areas – separations, fuels development, transmutation engineering, and systems analysis. The university student research programs at UNLV and IAC are being continued. Eight new Masters fellowships are being awarded.

In FY 2006, the Department will continue its fellowship program with the awarding of eight Masters fellowships and two Ph.D. fellowships. Directed university research to support advanced fuel cycles will be continued within the technical program areas. University student research programs will be continued at UNLV and IAC.

Small Business Innovative Research and Small Business Technology Transfer Programs	**0**	**1,000**	**1,662**
Total, Advanced Fuel Cycle Initiative	**65,750**	**67,462**	**70,000**

Explanation of Funding Changes

	FY 2006 vs. FY 2005 ($000)

Separations Technology Development

- **Proliferation-Resistant Fuel Treatment Experiments**
  Following successful laboratory scale separation of americium and curium from spent fuel in FY 2004, the AFCI program is continuing its research into advanced, proliferation-resistant aqueous treatment technologies, with emphasis on group actinide extraction techniques. As a result of these successes and other technical progress, the FY 2006 budget request includes an increase of $2,632,000 in FY 2006 to complete laboratory-scale hot testing of advanced aqueous processes, expand research on alternative advanced separation technologies, develop a pre-conceptual design for an advanced fuel cycle research laboratory at INL, and initiate collaboration with CEA to conduct a group actinide extraction test (GANEX)…….. +2,632

Advanced Fuels Development

- **LWR Oxide Fuel Development and Testing**

  In FY 2004, the first LWR oxide transmutation fuel irradiation test was successfully completed in the ATR. Post-irradiation examination will be completed in FY 2005. Results of non-destructive examinations to date indicate satisfactory behavior of the fuel pellets under irradiation. Based on this success, higher burnup LWR oxide transmutation fuels will be prepared for irradiation in FY 2006. Systems analysis studies conducted in FY 2004 indicated that inert matrix oxide fuels (IMF) may provide better transmutation performance than uranium bearing oxide fuels, so IMF irradiation tests are planned for FY 2005-2006. As a result of these successes, the FY 2006 budget request includes an increase of $3,500,000 to complete LWR oxide transmutation fuel, inert matrix fuel and ultra-high burn-up fuel irradiations and post-irradiation examination..... +3,500

- **Generation IV Reactor Fuel Development and Testing**

  In FY 2004 transuranic-bearing metal and nitride fuel samples were successfully irradiated in the ATR. Post-irradiation examination of these fuels is in progress. Results of non-destructive examinations to date indicate the satisfactory behavior of the fuel pellets under irradiation. These successful results will allow the Department to participate in the French FUTURIX program to test advanced transmutation fuels in the Phenix fast reactor. Test fuels for FUTURIX will be fabricated in FY 2006 and additional higher burnup metal and nitride fuel irradiation tests will be conducted in ATR to gain additional performance data. As a result of these successes and other technical progress, the FY 2006 budget request includes an increase of $3,599,000 to complete ATR irradiation experiments on metal, nitride, dispersion and inert matrix fuels for transmutation and Generation IV fast reactor systems. Additional collaborative fuels testing efforts are being initiated with France and Japan. Funding

	FY 2006 vs. FY 2005 ($000)
for the advanced gas reactor fuel development and qualification activities is fully funded in the Generation IV budget in FY 2006	+3,599
Total, Advanced Fuels Development	**+7,099**

Transmutation Engineering

The decrease of $8,834,000 reflects the expected FY 2005 completion of the design for the Materials Test Station at LANSCE.	-8,834

Systems Analysis

In FY 2004, the AFCI Systems Analysis team successfully developed a plan of action in collaboration with OCRWM to focus near-term research efforts on spent fuel treatment and transmutation technologies that will have the most impact on the AFCI waste management objective by improving geologic repository performance. Proliferation resistant fuel cycle studies were also successfully initiated in collaboration with NNSA safeguards experts and the Generation IV Proliferation Resistance and Physical Protection (PRPP) Evaluation Methodology Group. These analyses will be continued in FY 2005 and 2006 to enable technology decisions to be made sooner. As a result of these successes, the FY 2006 budget request includes an increase of $264,000 for broad systems studies, integrated fuel cycle system studies, and facility assessments, focusing principal activities on developing the information required to inform the 2007-2010 Secretarial recommendation on a second repository	+264

Transmutation Education

Based on the successful AFCI fellowship program for Masters level students over the past several years, the Department will continue this program and add Ph.D. fellowships as well. Many of the AFCI fellows have chosen careers in the nuclear science and engineering fields and some are now working at U.S. national laboratories. Student participation in the research conducted at UNLV and Idaho State University has contributed to these universities strong contribution to AFCI research. As a result of these successes, the FY 2006 budget request includes an increase of $715,000 for addition of Ph.D. level AFCI fellowships and an increased level of effort in university student research	+715

Small Business Innovative Research and Small Business Technology Transfer Programs

The increase of $662,000 is due to the increased funding for research and development activities	+662
Total Funding Change, Advanced Fuel Cycle Initiative	**+2,538**

Infrastructure
Funding Profile by Subprogram

(dollars in thousands)

	FY 2004 Comparable Appropriation	FY 2005 Original Appropriation	FY 2005 Adjustments	FY 2005 Comparable Appropriation	FY 2006 Request
Infrastructure					
Radiological Facilities Management	63,431	69,110	-547	68,563	64,800
Idaho Facilities Management	75,415	113,050	-897	112,153	97,862
Idaho Sitewide Safeguards and Security	56,343	58,103	-441	57,662	75,008
Total, Infrastructure	195,189[a]	240,263	-1,885	238,378	237,670

Funding Profile – Energy Supply

	FY 2004 Comparable Appropriation	FY 2005 Original Appropriation	FY 2005 Adjustments	FY 2005 Comparable Appropriation	FY 2006 Request
Infrastructure					
Radiological Facilities Management	63,431	69,110	-547	68,563	64,800
Idaho Facilities Management	54,119	92,164	-730	91,434	80,100
Total, Infrastructure	117,550	161,274	-1,277	159,997	144,900

Funding Profile – Other Defense Activities

	FY 2004 Comparable Appropriation	FY 2005 Original Appropriation	FY 2005 Adjustments	FY 2005 Comparable Appropriation	FY 2006 Request
Infrastructure					
Idaho Facilities Management	21,296	20,886	-167	20,719	17,762
Idaho Sitewide Safeguards and Security	56,343	58,103	-441	57,662	75,008
Total, Infrastructure	77,639	78,989	-608	78,381	92,770

[a] Includes $3.17M identified as use of prior year balances to fund the Environmental Management liability for OVEC in FY 2004.

Mission

The mission of the Infrastructure program is to manage the planning, acquisition, operation, maintenance, and disposition of nuclear facilities and infrastructure to meet the growing demand for isotopes used in medicine, scientific research and homeland security; to provide radioisotope power systems for space exploration and national security; to conduct advanced nuclear energy research; and to ensure the long term future of the domestic nuclear fuel supply.

The Infrastructure program provides for the stewardship of the vital field infrastructure maintained by the Office of Nuclear Energy, Science and Technology (NE). This infrastructure is required to accomplish the assigned missions in areas such as Generation IV nuclear energy research and development, Advanced Fuel Cycle Initiative, space nuclear power applications, production of isotopes for medicine and industry, and naval nuclear propulsion research and development.

Benefits

The Infrastructure program keeps unique DOE facilities and supporting infrastructure in a user-ready status. Facilities supported by this program include reactors, hot cells, and other vital infrastructure needed to carry out advanced nuclear energy technology research and development; construct power systems essential for important national security missions and space exploration; produce, package, and ship radioisotopes for medical and scientific applications; and test new fuels and core components for the Naval Nuclear Propulsion Program. DOE stimulates great advances in science by making its nuclear facilities available to a large user base. The Department does not subsidize direct operational costs related to users, but it does maintain unique radiological facilities and capabilities in a manner that supports their application to missions from various governmental and scientific users.

Beginning in the second quarter of FY 2005, the Idaho National Engineering and Environmental Laboratory (INEEL) will be merged with Argonne National Laboratory-West (ANL-W) to create the Idaho National Laboratory (INL). The Secretary of Energy has designated INL as the center for the Department's strategic nuclear energy research and development efforts. The INL will play a lead role in Generation IV nuclear energy systems development, advanced fuel cycle development, testing of naval reactor fuels and reactor core components, and space nuclear power applications. While the laboratory has transitioned its research and development focus to nuclear energy programs, it is also maintaining its multi-program national laboratory status to serve a variety of current and planned Department and national research and development missions.

Two important research reactors currently operating at this site are the Advanced Test Reactor (ATR) and its supporting ATR Critical Facility. ATR is one of the world's largest and most sophisticated test reactors. It will be a crucial facility in the development of the Generation IV reactor and the Advanced Fuel Cycle Initiative. In addition, ATR currently conducts virtually all irradiation testing of Navy reactor fuels and core components and is vital to achieving the Department's goal of providing the U.S. Navy with safe, militarily effective, nuclear propulsion plants and ensuring their continued safe and reliable operation. The Navy mission is projected to continue until at least mid-century.

The Infrastructure program supports "National Energy Policy" goals by maintaining and operating important landlord infrastructure required for the support of facilities dedicated both to advanced nuclear energy technology research and development and multi-program use. The Landlord manages common-use equipment, facilities, land, and support services that are not directly funded by programs. Key

activities conducted under these programs include ensuring that all landlord facilities meet essential safety and environmental requirements and are maintained at user-ready levels. Other key activities include managing all special nuclear materials contained in these facilities and the disposition of DOE legacy waste materials under NE ownership.

In March 2000, the Nuclear Energy Research Advisory Committee (NERAC) led the creation of the "Nuclear Science and Technology Infrastructure Roadmap" for the entire Department. This study examined the capabilities of the DOE's accelerators, reactors, and hot cells. It also evaluated current nuclear technology missions and facility staffing levels. Finally, the Roadmap estimated future mission requirements and compared them to available and planned facility capabilities, highlighting capability gaps. The Department is refining this analysis with a series of more detailed, site-specific assessments that will not only highlight infrastructure gaps, but also identify requirements for maintenance and upgrade of existing facilities. As a first step, a NERAC task force examined the nuclear R&D infrastructure at the INL to identify the maintenance and upgrades required to meet the Department's nuclear R&D activities planned at Idaho. This assessment was completed in November 2003. Building on this assessment, NERAC created a Subcommittee on Nuclear Laboratory Requirements to identify what characteristics, capabilities, and attributes a world-class nuclear laboratory would possess. This Subcommittee became familiar with the practices, culture, and facilities of other world-class laboratories and used this knowledge in FY 2004 to recommend what needs to be implemented at Idaho. The objective of this activity was to help make Idaho National Laboratory the leading nuclear energy research laboratory in the world within ten years of its inception. DOE and INL are now working to implement the recommendations of both NERAC reports.

Strategic and Program Goals

The Department's Strategic Plan identifies four strategic goals (one each for defense, energy, science, and environmental aspects of the mission) plus seven general goals that tie to the strategic goals. The Infrastructure program supports the following goal:

Energy Strategic Goal

General Goal 4, Energy Security: Improve energy security by developing technologies that foster a diverse supply of reliable, affordable and environmentally sound energy by providing for reliable delivery of energy, guarding against energy emergencies, exploring advanced technologies that make a fundamental improvement in our mix of energy options, and improving energy efficiency.

The Infrastructure program has one program goal that contributes to General Goal 4 in the "goal cascade":

Program Goal 04.17.00.00: Maintain and enhance the national nuclear infrastructure to meet the Nation's energy, environmental, medical research, space exploration, and national security needs.

Contribution to Program Goal 04.17.00.00 (Maintain and enhance the Nation's nuclear infrastructure capability)

The Infrastructure program contributes to this goal by ensuring that the Department's unique facilities, required for advanced nuclear energy technology research and development, are maintained and operated such that they are available to support national priorities. The program manages site equipment, facilities, land, and supporting services that are not directly supported by other programs. Key activities conducted under this program include ensuring that all NE facilities meet essential safety and environmental requirements and are maintained at user-ready levels. Other key activities include managing all special nuclear materials contained in these facilities and the disposition of DOE legacy materials under NE ownership.

Annual Performance Results and Targets

FY 2001 Results	FY 2002 Results	FY 2003 Results	FY 2004 Results	FY 2005 Targets	FY 2006 Targets
Program Goal 04.17.00.00 (Energy Security)					
Infrastructure				*Consistent with safe operations, achieve cumulative variance of less than 10 percent from each of the cost and schedule baselines for the Radiological Facilities Management and Idaho Facilities Management programs.*	*Consistent with safe operations, achieve cumulative variance of less than 10 percent from each of the cost and schedule baselines for the Radiological Facilities Management and Idaho Facilities Management programs.*
Radiological Facilities Management					
	Complete 80 percent of the construction of the Los Alamos Isotope Production Facility, which is needed for the production of short-lived radioisotopes essential for U.S. medical research. (MET GOAL)	*Keep cost and schedule milestones for upgrades and construction of key nuclear facilities within 10 percent of approved baselines. (MET GOAL)*	*Keep cost and schedule milestones for upgrades and construction of key nuclear facilities within 10 percent of approved baselines, using the cost-weighted mean percent variance (+/-10 percent) approach. (MET GOAL)*		
		Safely operate each key nuclear facility within 10 percent of the approved plan, shutting down reactors if they are not operated within their safety envelope and expediting remedial action. (MET GOAL)	*Consistent with safe operations, maintain and operate key nuclear facilities so the unscheduled operational downtime will be kept to less than 10 percent, on average, of total scheduled operating time. (MET GOAL)*		
	Demonstrate the operational capability of radioisotope power systems infrastructure by fabricating quality products at each of the major facilities (i.e., at least eight iridium clad vent sets at ORNL and at least eight encapsulated Pu-238 fuel pellets at LANL). (MET GOAL)	Demonstrate the operational capability of radioisotope power systems infrastructure by fabricating flight quality products at each of the major facilities (i.e., at least eight iridium clad vent sets at ORNL and at least eight encapsulated Pu-238 fuel pellets at LANL), and by processing at least 2 kilograms of scrap Pu-238 at LANL. (MET GOAL)	*Maintain and operate radioisotope power systems facilities with less than 10 percent unscheduled downtime from approved baseline. (MET GOAL)*		

FY 2001 Results	FY 2002 Results	FY 2003 Results	FY 2004 Results	FY 2005 Targets	FY 2006 Targets
	Bring the full-scale scrap recovery line to full operation and begin processing Pu-238 scrap for reuse in ongoing and future missions requiring use of radioisotope power systems. (MIXED RESULTS)				
Idaho Facilities Management					
	Meet the milestones for legacy waste cleanup at Test Reactor Area (TRA) in the Voluntary Consent Order between the State of Idaho and DOE, and efficiently manage resources to limit growth in backlog of maintenance to no more than 10 percent. (MET GOAL)		*Keep cost and schedule milestones for upgrades and construction of key nuclear facilities within 10 percent of approved baselines, using the cost-weighted mean percent variance (+/-10 percent) approach. (same target used for Radiological Facilities Management)* *(MET GOAL)*		
					Validate the Asset Condition Index (ACI)—a corporate measure of the condition of facility assets based on industry inspection and deficiency standards—and achieve an ACI rating of good for 45-50 percent of active mission-critical INL-NE facilities.
Idaho Sitewide Safeguards and Security					
	During FY 2002, no national security incidents occurred within NE Idaho sitewide cyber systems and security areas that caused unacceptable risk or damage to the Department. (MET GOAL)	Complete the Idaho Integrated Safeguards and Security Plan to assure appropriate protective measures are taken commensurate with the risks and consequences for both the laboratories on the Idaho site. (MET GOAL)	Issue the Design Basis Threat Implementation Plan for the Idaho National Engineering and Environmental Laboratory and Argonne National Laboratory-West. (MET GOAL)	Complete FY 2005 actions at the Idaho Site required to implement the May 2003 Design Basis Threat (DBT) as defined in the Program Management Plan that remain consistent with the requirements of the October 2004 DBT.	Install all physical protective systems and augment the Security Police Officer force as outlined in the Integrated Design Basis Threat Implementation Plan.

Means and Strategies

NE will use various means and strategies to achieve its program goals. However, various external factors may impact the ability to achieve these goals. NE also performs collaborative activities to help meet its goals.

The Department will implement the following means:

- Ensure that mission essential systems, resources, and services are identified to conduct priority missions for the Department and are maintained and operated in compliance with DOE, Federal, and State safety and environmental requirements in a secure and cost-effective manner. For Idaho Facilities Management, this will be accomplished by the implementation of the "INL Ten Year Site Plan" that will be updated annually.

- Maintain isotope production facilities in a ready, safe and environmentally compliant condition and maintain the unique infrastructure and capability to deliver advanced radioisotope power systems for space and national security missions.

The Department will implement the following strategies:

- Idaho Facilities Management mission essential facilities will be identified in the "INL Ten Year Site Plan." Detailed work planning and funding requests will result from implementation of this Plan that will be updated annually.

- Efficient use of existing facilities and staff, backup supply agreements, upgrade of present facilities, purchase of needed equipment, and investing in new facilities as warranted by demand. The challenges to the program will continue as scientific and medical research result in increased demand for new isotope products.

The following external factors could affect NE's ability to achieve its strategic goal:

- Medical Isotope Infrastructure Key External Factors: The Department is working to fully address its customers' requirements and to forecast future trends. This is being done through frequent interactions between customers and Program staff; data obtained from site visits and attendance at society exhibitions (e.g., the Society of Nuclear Medicine); and coordination of isotope activities with stakeholders in the isotope community including other Federal agencies. Research on market sizes, pricing pressures, competition, and customer feedback also is being obtained through independent surveys and studies, as well as Program management assessments. For example, reports of both the NERAC Subcommittee and an Expert Panel convened by the Medical University of South Carolina in 1998 observed that the program's infrastructure cannot adequately keep pace with the changing needs of the research community.

- Idaho Facilities Management Key External Factors: Energy policy changes related to the emphasis on future nuclear energy R&D would impact the focus and direction of the Idaho Facilities Management Program, but not necessarily its overall cost and long-term liabilities. Increased nuclear energy R&D needs resulting from new mission initiatives could require accelerated recapitalization to support enhanced use of research facilities and earlier enhancement of the existing infrastructure. On the other hand, reduced nuclear energy R&D could generate a larger near-term

inventory of excess facilities and shift funding needs from upgrades and improvements to disposition (e.g., clean-up and dismantlement).

With the award of the new Idaho National Laboratory contract, Idaho will become a truly multi-program national laboratory with NE being the lead program. Through their Idaho Operations Office, NE will integrate and oversee program activities and manage the Department of Energy and Work for Others contracts. The Office of Environmental Management (EM), in executing the Idaho Cleanup Project (ICP), will initially be the largest program at the site, but that will change rapidly over time as the clean-up progresses. As EM completes its cleanup activities, facilities will be returned to NE. Thus, the Idaho Facilities Management program will adjust its activities to accommodate needs of the ICP.

In carrying out the program's mission, NE performs the following collaborative activities:

- Coordinates with national security agencies and NASA to develop radioisotope power systems for their use to ensure proposed systems and technologies satisfy the necessary technical requirements identified by customers for identified mission scenarios.

- The Department finances all isotope production and distribution expenses through cash collections from both federal and non-federal customers. The program is working to fully address its customers' requirements and to forecast future trends. This is being done through frequent interactions between customers and program staff, data obtained from customer site visits and attendance at society conferences (*e.g.*, the Society of Nuclear Medicine), and coordination of isotope activities with stakeholders in the isotope community, including other Federal agencies.

Validation and Verification

To validate and verify program performance, NE will conduct various internal and external reviews and audits. NE's programmatic activities are subject to continuing review by the Congress, the General Accountability Office, the Department's Inspector General, the Nuclear Regulatory Commission, the U.S. Environmental Protection Agency, state environmental and health agencies, the Defense Nuclear Facilities Safety Board, and the Department's Office of Engineering and Construction Management (including DOE Real Property Management Order). In addition, NE provides continual management and oversight of its vital field infrastructure programs—the Radiological Facilities Management program, the Idaho Facilities Management program, and the Idaho Sitewide Safeguards and Security program. Periodic internal and external program reviews evaluate progress against established plans. These reviews provide an opportunity to verify and validate performance. Monthly, quarterly, semi-annual and annual reviews, consistent with program management plans, are held to ensure technical progress, cost and schedule adherence, and responsiveness to program requirements.

NERAC subcommittees evaluate progress of NE's research and development programs. NERAC similarly reviews specific program plans as they are being formulated. In early FY 2004, NERAC established a Subcommittee on Evaluations. The full NERAC and its subcommittees have provided independent evaluations in the past, but these evaluations never comprehensively covered the entire nuclear energy program. The new Subcommittee engages appropriate experts to monitor, on a continual basis designated NE programs and evaluate the progress of these programs against (a) direction and guidance provided by the full NERAC and (b) program plans and performance measures developed by

the program under evaluation. This Subcommittee provides arm's length, independent assessments that are critical to OMB's evaluation of NE programs.

Program Assessment Rating Tool (PART)

The Department implemented a tool to evaluate selected programs. PART was developed by OMB to provide a standardized way to assess the effectiveness of the Federal Government's portfolio of programs. The structured framework of the PART provides a means through which programs can assess their activities differently than through traditional reviews. The Infrastructure program has incorporated feedback from OMB during the FY 2006 assessment into the FY 2006 Budget Request and has taken or will take the necessary steps to continue to improve performance.

The results of the FY 2006 review are reflected in the FY 2006 Budget Request as follows:

The assessment found that the program is effectively targeted through the formal Idaho National Laboratory Ten Year Site Plan that identifies the mission-essential infrastructure and facilities, planned annual work scope, and performance measures for the laboratory. An overall PART score of 49 was achieved with a perfect 100 score for Section I, Program Purpose & Design; a score of 89 for Section II, Strategic Planning; a perfect 100 score for Section III, Program Management; and a score of 0 for Section IV, Program Results/Accountability. This is a new program and accomplishments have yet to be demonstrated.

Funding by General and Program Goal

(dollars in thousands)

	FY 2004	FY 2005	FY 2006
General Goal 4, Energy Security			
Program Goal 04.17.00.00: Maintain and enhance the national nuclear infrastructure capability	195,189	238,378	237,670
Total, General Goal 4 (Infrastructure)	195,189	238,378	237,670

Radiological Facilities Management

Funding Schedule by Activity

(dollars in thousands)

	FY 2004	FY 2005	FY 2006	$ Change	% Change
Radiological Facilities Management					
Space and Defense Infrastructure	35,544	33,532	31,200	-2,332	-7.0%
Medical Isotopes Infrastructure	27,887	34,535	33,100	-1,435	-4.2%
Enrichment Facility Infrastructure	0	496	500	+4	+0.8%
Total, Radiological Facilities Management	63,431	68,563	64,800	-3,763	-5.5%

Description

The mission of the Radiological Facilities Management program is to maintain critical user facilities in a safe, environmentally-compliant and cost-effective manner to support national priorities. The Radiological Facilities Management program funds the management of the Department's vital resources and capabilities at Office of Nuclear Energy, Science and Technology (NE)-managed facilities at Oak Ridge National Laboratory (ORNL), Los Alamos National Laboratory (LANL), Sandia National Laboratories (SNL), Brookhaven National Laboratory (BNL), and Idaho National Laboratory (INL). In addition, the Radiological Facilities Management program assures appropriate oversight of the operations and maintenance of the Department's Paducah Gaseous Diffusion Plant (Paducah GDP) uranium enrichment facilities to assure that USEC Inc. (USEC) meets its commitments under the 2002 DOE-USEC Agreement for the maintenance of a domestic enriched uranium fuel supply.

Benefits

These funds assure that NE facilities meet essential safety and environmental requirements and are maintained at user-ready levels. Actual operations, production, research, or other additional activities are funded either by other DOE programs, by the private sector, or by other Federal agency users.

At INL, the Department is completing the transfer of the radioisotope heat source and power system assembly and testing program from the Mound Plant in Ohio. Following the events of September 11, 2001, the Department identified the need to enhance security at the Mound Site or to transfer operations to another site where security was already in place. The components and systems at Mound containing Plutonium-238 (Pu-238) were transferred to ANL-W on an interim basis for safe and secure storage pending a final decision. After completing an Environmental Assessment and cost evaluations on a range of alternative actions, the Department decided to permanently locate the operations at INL. The transfer of equipment was completed in FY 2003 and installation of this transferred equipment into building additions or modifications proceeded during FY 2004. The transferred capability will become operational in early 2005 and will be fully functioning throughout FY 2006. In addition, the Department will transfer its inventory of neptunium-237 (Np-237) from the Savannah River Site to the INL during FY 2005 and FY 2006.

At ORNL, the Radiological Facilities Management program maintains the unique infrastructure for iridium fabrication. Iridium is the cladding used to encapsulate Pu-238 for use in space and national security missions, and ORNL maintains the only U.S. capability to process and fabricate iridium into the necessary cladding configuration.

At ORNL, this program also maintains Building 3047 Hot Cells in a safe and environmentally compliant condition for the production, packaging, and shipment of radioisotopes used in medicine, homeland security applications, and scientific research. The Chemical and Materials Laboratories in Building 9204-3 are used for stable isotope processing. Stable isotopes are used as feed material for radioisotopes and in medical and scientific research.

Additionally, the Department maintains 1.5 metric tons of uranium at ORNL which contains 450 kilograms of U-233. This material is stored in ORNL's Building 3019, a Manhattan Project-era facility that presents fire safety and contamination hazards. The storage containers require close inspection to verify their integrity that is not possible in the current storage configuration. Further, the storage of this fissile material requires expensive security precautions. The Department, therefore, launched the Uranium-233 Disposition, Medical Isotope Production, and Building 3019 Complex Shutdown Preliminary Project (U-233 Project) to down-blend this material into a form not useable for weapons (thereby reducing the danger posed by excess fissile materials and reducing security costs) and resolve the safety issues associated with its storage. While the material is processed, the project will extract important medical isotopes that are needed by researchers developing new treatments for difficult and deadly cancers.

At LANL, this program maintains the Pu-238 encapsulation and scrap recovery facilities in the Plutonium Facility (designated PF-4) in Technical Area-55. These facilities provide the only U.S. capability to process, pelletize and encapsulate the Pu-238 making it safe to use in radioisotope power systems. Also at LANL is the newly constructed Isotope Production Facility. This facility is producing medical and scientific research isotopes sold world wide.

The Radiological Facilities Management program also maintains the Annular Core Research Reactor (ACRR) and associated hot cells at SNL; and the Brookhaven Linear Isotope Producer (BLIP) Building 931 and Hot Cell Building 801 which is used for isotope processing at BNL.

The DOE-owned Paducah GDP is the only operating domestic enriched uranium production facility. Its continued operation is essential to assure an adequate supply of nuclear fuel for the Nation's electric utilities. The Paducah GDP lessee, USEC, committed, in a DOE-USEC Memorandum of Agreement on June 17, 2002, to maintain the long-term operability of the Department-owned Paducah GDP until USEC deploys new centrifuge enrichment technology by the end of this decade. The Department will review and analyze operating and maintenance data, and observe industrial activities at the Paducah GDP, and validate GDP maintenance on site each year, in order to assure USEC is meeting its commitments under the DOE-USEC Agreement and that Government's rights and options are being preserved.

The FY 2006 budget requests funding to manage the Department's vital resources and capabilities at INL, ORNL, LANL, SNL, BNL, and the Department's Paducah GDP to ensure that DOE missions can be met in a safe, environmentally-compliant and cost effective manner.

Detailed Justification

(dollars in thousands)

	FY 2004	FY 2005	FY 2006
Space and Defense Infrastructure	**35,544**	**33,532**	**31,200**
▪ **Idaho National Laboratory (INL)**	**19,244**	**14,732**	**12,200**
• **Radioisotope Power Systems Assembly Operations**	**9,044**	**9,432**	**7,500**

Transfer of the capability to assemble and test radioisotope power systems from the Mound Plant in Ohio to the INL is essentially complete. Equipment transfer was completed in FY 2003 and efforts in FY 2004 focused on completing required building additions and modifications and on installing the transferred equipment in these buildings and on setting up an interim production line to support a near term national security application. During early FY 2005, the remaining transferred equipment will be installed and the transferred capability will become operational. Fueling operations for the Pluto/New Horizons mission will begin in mid-FY 2005. In addition, in FY 2005 the receipt and storage of Np-237 will become part of the radioisotope power systems infrastructure. In FY 2006, the effort will be reduced to that required to maintain the facilities in a fully operational mode so that the assembly and testing capabilities will be available to support two national security customers and the qualification of an advanced multi-mission radioisotope thermoelectric generator and a Stirling radioisotope power system for the National Aeronautics and Space Administration.

• **Capital Equipment for Radioisotope Power System Assembly Operations**	**800**	**800**	**200**

Though significant amounts of equipment were transferred from Mound, some new equipment is required to support the heat source test and assembly operations at INL. These equipment purchases will continue into FY 2005. In FY 2006, capital equipment for the assembly and testing activities will be reduced to the level required for routine maintenance and infrastructure support.

• **General Plant Project (GPP) for Modifying Building 792 and for related site infrastructure upgrades**	**5,100**	**0**	**0**

The GPP budget line included two major GPP projects. The first involved modifications to Building 792 that supported the transfer of the heat source and radioisotope power system assembly and testing operations transferred from the Mound Plant in Ohio. The second supported other site infrastructure projects not directly related to the Building 792 modifications. Both GPP projects will be completed with FY 2004 funding.

(dollars in thousands)

	FY 2004	FY 2005	FY 2006
• **Np-237 Transfer/Storage**	**1,000**	**0**	**0**

In late FY 2004, the Department decided to transfer its inventory of Np-237 (needed as the irradiation target material in future Pu-238 production) from the Savannah River Site to the INL. This Np-237 material is currently stored under the auspices of the Environmental Management program, and the Department has committed to complete stabilization of this material by the end of FY 2006. To accommodate that schedule, INL will begin to receive shipments of Np-237 in early FY 2005, continuing through FY 2006, and place the material in storage. Funding for the receipt and storage is included as part of Radioisotope Power Systems Assembly Operations beginning in FY 2005.

• **Safety/Program Analysis and Testing Infrastructure**	**3,300**	**4,500**	**4,500**

The Department maintains an analytical and testing infrastructure that enables the Department to analyze the performance and ensure the safety of its radioisotope power systems. This capability includes the operation and update of sophisticated analytical codes that can analyze the behavior of materials and systems under potential accident environments. In addition, this capability enables the conduct of specialized tests and maintenance of equipment that can simulate the environments that these materials and systems could be subjected to during potential extreme accident or operational scenarios. In FY 2006, analysis techniques and computer codes will be updated to incorporate more advanced capabilities that can provide more accurate and detailed projections in support of future missions. Effort will also proceed on establishing a consolidated safety and testing infrastructure at INL or other laboratories.

▪ **Los Alamos National Laboratory (LANL)**	**12,200**	**13,800**	**14,000**
• **Pu-238 Encapsulation and Scrap Recovery Facilities**	**10,200**	**12,500**	**12,700**

The Department maintains and operates dedicated Pu-238 processing, encapsulation, and scrap recovery facilities within the Plutonium Facility (PF-4) at Technical Area 55 at LANL. Operations in these facilities were suspended in July 2004 as part of a site wide stand down. Approval to resume operations in these facilities was received in November 2004 and the facilities should be in full operation early in the second quarter of FY 2006. This site wide stand down delayed activities related to startup of the new full-scale scrap recovery line so that it will not receive approval to start up operations until late in FY 2005. When operational, this line and the bench scale scrap recovery line will provide the plutonium-238 that will be used in the encapsulation lines to support missions over the next several years. In addition, the treatment of waste residues that have built up over several years will begin in mid FY 2005, with increased effort during FY 2006. This will put the material in a form suitable for long term storage or disposal.

	(dollars in thousands)		
	FY 2004	FY 2005	FY 2006
• **Capital Equipment for the Pu-238 Facilities**	**2,000**	**1,300**	**1,300**

Maintenance of the Pu-238 facilities requires regular upgrades and replacement of gloveboxes and equipment in the processing, encapsulation, and scrap recovery lines. During FY 2004, replacement of gloveboxes in the processing and encapsulation facilities continued and equipment was purchased to initiate consolidation of the Pu-238 chemical and isotopic analyses within the TA-55 complex at LANL. Installation of the new gloveboxes in FY 2005 and retrofits of existing gloveboxes in FY 2006 will continue in support of establishing the isotopic analysis capabilities within TA-55.

▪ **Oak Ridge National Laboratory (ORNL)**	**4,100**	**5,000**	**5,000**
• **Iridium Fabrication Facilities for Radioisotope Power Systems**	**3,900**	**4,500**	**4,500**

The Department maintains a unique infrastructure and capability at ORNL to fabricate iridium cladding and carbon insulators used to encapsulate and contain the Pu-238 pellets used in radioisotope power systems. These heat source components are necessary for the safe operation of the radioisotope power systems. FY 2006 funding will continue to ensure the operational capability of this facility.

• **Capital Equipment for Iridium Fabrication Facilities**	**200**	**500**	**500**

In FY 2006, ORNL will continue to upgrade and replace rolling mills to support iridium processing and fabrication at ORNL.

Medical Isotopes Infrastructure	**27,887**	**34,535**	**33,100**
▪ **Oak Ridge National Laboratory (ORNL)**	**20,300**	**26,350**	**25,028**
• **Building 3047 Hot Cells**	**2,650**	**2,664**	**2,900**

Maintain facility in a safe and environmentally compliant condition for processing, packaging, and shipment of radioisotopes and other related services needed in medical diagnostic and therapeutic applications and other scientific research used by Federal and non-Federal entities. Activities include maintenance, radiological monitoring, and facility inspections. Isotope customers will pay the full cost of isotope processing in this facility.

• **Building 5500 – Chemical and Materials Laboratories**	**1,250**	**1,675**	**1,800**

Maintain the two laboratories in a safe and environmentally compliant condition for the processing, packaging, and shipment of stable isotopes and other services needed in medical diagnostic and therapeutic applications and other scientific research used by Federal and non-Federal entities. Activities include maintenance, radiological monitoring, and facility inspections.

(dollars in thousands)

	FY 2004	FY 2005	FY 2006
• **Building 9204-3, Calutron Building Y-12**	**1,250**	**973**	**973**

Continue to fund surveillance and maintenance activities necessary for cold stand-by of the Calutrons at Y-12.

• **Other ORNL Facilities**	**1,900**	**0**	**0**

FY 2004 funding provided for infrastructure upgrades at various ORNL facilities.

• **Isotope Production**	**450**	**600**	**650**

In accordance with the "President's Management Agenda" goals, "Improved Financial Performance" and "Expand Electronic Government", in FY 2003, NE integrated and automated its isotope business management information and consolidated it from three national laboratories to one laboratory, thus reducing overall costs. Such activities include isotope order processing, billing, official quotations, shipping schedules, cash collections, advance payments, and accounting for products and services provided by all Department isotope producing sites. Also, the Department is continuing to apply a more formal process started in FY 2003 for the selection of research isotopes for production and distribution of research isotopes called the Nuclear Energy Protocol for Research Isotopes (NEPRI). The NEPRI process was also centralized at ORNL along with the new automated business system. This E-Government isotope business management information system not only expedites customer orders but also saves several hundreds of thousands of dollars of administration expenses annually.

• **Uranium-233 (U-233) Program**	**12,800**	**6,929**	**0**

The U-233 Program provides funding for traditional "Other Project Costs" including program planning, safety analysis, and conceptual design. It also funds building support costs prior to construction. The balance of FY 2004 funding was used to advance the preliminary design of the Facility Modification for U-233 Disposition project (05-E-203). Critical Decision-1 (CD-1) was approved in May 2004 with the condition that additional design work be completed and independently verified prior to the proposal of a performance baseline. No U-233 program funding is requested in FY 2006.

• **05-E-203, Facility Modification for ^{233}U Disposition**	**0**	**13,509**	**18,705**

The ^{233}U Disposition, Medical Isotope Production and Building 3019 Complex Shutdown project will increase the availability of medically valuable isotopes by processing the DOE ^{233}U inventory at Oak Ridge; and resolve legacy safety and security issues associated with the inventory and its storage facility. FY 2005 funding will fund the completion of the project engineering, design and analysis necessary to support a performance baseline. After the performance baseline is approved in Critical Decision-2, it will be used to complete a revised business case for the project and a recommendation relative to proceeding to construction of the building modifications. The FY 2006 request will fund the final design and the first year of construction for the building modifications project. The updated business case will be submitted to Congress prior to proceeding with the physical modifications in accordance language contained in the conference report of the House and Senate Committees on Appropriations (HR 107-681).

	(dollars in thousands)		
	FY 2004	FY 2005	FY 2006
▪ **Los Alamos National Laboratory (LANL)**	**3,012**	**3,160**	**2,922**
• **Isotope Production Facility/TA-48 Hot Cell, Building RC-1**	**1,750**	**2,850**	**2,922**

Maintain facilities in a safe and environmentally compliant condition for the production, processing, packaging, and shipment of radioisotopes and other services needed in medical diagnostic and therapeutic applications, and other scientific research used by Federal and non-Federal entities. Activities include maintenance, radiological monitoring, and facility inspections. Isotope customers will pay the full cost of isotope processing in these facilities.

• **Isotope Production Facility – Other Project and Start-up and Maintenance Costs**	**1,262**	**0**	**0**

Start-up expenses associated with the Isotope Production Facility (IPF) target station and beam line. This facility was completed in FY 2004 and will be in production in FY 2005.

• **Capital Equipment**	**0**	**310**	**0**

In FY 2005, procure type A and type B shipping containers needed to transport isotopes between the IPF and the hot cells and to customers.

▪ **Sandia National Laboratories (SNL)**	**1,750**	**1,900**	**2,000**
• **TA-5 ACRR & Hot Cells**	**1,750**	**1,900**	**2,000**

Support operations of the vital facilities in Sandia's Technical Area 5 (TA-5). Specifically, this activity includes maintaining the Annular Core Research Reactor (ACRR) in a safe, environmentally compliant condition and state of readiness, and maintaining the associated hot cells in a non-nuclear stand-by status. Activities include maintenance, radiological monitoring, and facility inspections.

▪ **Brookhaven National Laboratory (BNL)**	**2,373**	**2,673**	**2,650**
• **Brookhaven Linear Isotope Producer (BLIP) Building 931 and Hot Cell Building 801**	**2,075**	**2,558**	**2,650**

Maintain the BLIP Building 931 and Hot Cell Building 801 facilities in a safe, environmentally compliant condition and state of readiness for the production of radioisotopes and other services needed in medical diagnostic, therapeutic applications, and other scientific research used by Federal and non-Federal entities. Activities include maintenance, radiological monitoring, and facility inspections. Isotope customers will pay the full cost of isotope processing in this facility.

• **Capital Equipment**	**298**	**115**	**0**

In FY 2005, the program will purchase capital equipment, such as a hot cell manipulator and a fume hood ventilation system.

(dollars in thousands)

	FY 2004	FY 2005	FY 2006
▪ **Other Activities**	**452**	**452**	**500**
• **Associated Nuclear Support**	**452**	**452**	**500**

This funding provides for requirements applicable to isotope producing sites. Such items include annual Nuclear Regulatory Commission certification of isotope shipping casks, independent financial audits of the revolving fund, and other related expenses.

Enrichment Facility Infrastructure	**0**	**496**	**500**
▪ **Oak Ridge Operations Office**	**0**	**496**	**500**

Funding provides for oversight and monitoring of the maintenance of its leased assets at the Paducah Gaseous Diffusion Plant. Under the DOE-USEC Agreement of June 17, 2002, USEC is required to maintain the Paducah GDP in a certain operable condition. The Department has the right to inspect the facilities to verify the USEC maintenance program is meeting the terms of the Agreement. The program will inspect and analyze operating and maintenance data, and observe industrial activities at the Paducah GDP, and validate GDP maintenance each year, in order to assure that USEC Inc. is meeting its commitments and that the Government's rights and options are preserved.

Total, Radiological Facilities Management	**63,431**	**68,563**	**64,800**

Explanation of Funding Changes

	FY 2006 vs. FY 2005 ($000)
Space and Defense Infrastructure	
▪ **Idaho National Laboratory (INL)**	
• **Radioisotope Power Systems Assembly Operations**	
The decrease of $1,932,000 in operating funds reflects the completion of those activities associated with establishing the heat source and radioisotope power system assembly and testing operations at INL and the transition to infrastructure level funding	-1,932
• **Capital Equipment for Radioisotope Power System Assembly Operations**	
The decrease of $600,000 in capital equipment funds reflects reducing the level of equipment for the assembly and testing activities to the level required for routine maintenance and infrastructure support	-600
• **Total, INL**	**-2,532**

	FY 2006 vs. FY 2005 ($000)
▪ **Los Alamos National Laboratory (LANL)**	
• **Pu-238 Encapsulation and Scrap Recovery Facilities**	
The increase of $200,000 will be used to increase efforts to process residues stored from prior year operations	+200
Total, Space and Defense Infrastructure	**-2,332**
Medical Isotopes Infrastructure	
▪ **Oak Ridge National Laboratory (ORNL)**	
• **Building 3047 Hot Cells**	
The increase of $236,000 will permit needed minor repairs and keep the maintenance schedule current	+236
• **Building 5500 – Chemical and Materials Laboratories**	
The increase of $125,000 will permit keeping the maintenance schedule current and purchase of minor lab equipment and supplies	+125
• **Isotope Production**	
The increase of $50,000 will permit upgrades to the current system to accommodate electronic ordering, payments, and transfer of cash collections to the producing sites and maintain inventory control	+50
• **Uranium-233 Program**	
The decrease of $6,929,000 reflects the shift of operating funds to construction funds that are requested in the Facility Modification for 233U Disposition line item. Funds will be requested in FY 2007 in the Uranium-233 Program account for start-up testing and commissioning related activities	-6,929
• **Facility Modification for ^{233}U Disposition**	
The increase of $5,196,000 reflects costs for Building 3019 capital improvements and construction support activities needed for processing the Uranium-233 under the Uranium-233 Program	+5,196
▪ **Total, ORNL**	**-1,322**

	FY 2006 vs. FY 2005 ($000)
▪ **Los Alamos National Laboratory (LANL)**	
• **Isotope Production Facility/TA-48 Hot Cell, Building RC-1**	
The increase of $72,000 will be used to maintain the facility consistent with the FY 2005 funding level. Isotope customers will pay the full cost of isotope processing in these facilities	+72
• **Capital Equipment**	
The decrease of $310,000 reflects shipping containers purchased in FY 2005 for transportation of isotopes between facilities and customers	-310
▪ **Total, LANL**	**-238**
▪ **Sandia National Laboratories (SNL)**	
• **TA-5 ACRR & Hot Cells**	
The increase of $100,000 will support additional maintenance activities	+100
▪ **Total, SNL**	**+100**
▪ **Brookhaven National Laboratory (BNL)**	
• **Brookhaven Linear Isotope Producer Building 931 and Hot Cell Building 801**	
The increase of $92,000 will be used to address additional maintenance requirements	+92
• **Capital Equipment**	
The decrease of $115,000 reflects completing purchases and installation of equipment requested in FY 2004	-115
▪ **Total, BNL**	**-23**
▪ **Other Activities**	
• **Associated Nuclear Support**	
The increase of $48,000 provides level of funding for requirements applicable to isotope producing sites	+48
Total, Medical Isotopes Infrastructure	**-1,435**
Enrichment Facility Infrastructure	
▪ **Oak Ridge Operations Office**	
• **Enrichment Facility Infrastructure**	
The increase of $4,000 from FY 2005 to FY 2006 is due to the FY 2005 rescission	+4
Total Funding Change, Radiological Facilities Management	**-3,763**

Capital Operating Expenses and Construction Summary

Capital Operating Expenses

(dollars in thousands)

	FY 2004	FY 2005	FY 2006	$ Change	% Change
Capital Equipment	3,298	3,025	2,000	-1,025	-33.9%
General Plant Projects/General Purpose Equipment	5,100	0	0	+0	+0.0%
Total, Capital Operating Expenses	8,398	3,025	2,000	-1,025	-33.9%

Construction Projects

(dollars in thousands)

	Total Estimated Cost (TEC)	Prior-Year Appropriations	FY 2004	FY 2005	FY 2006	Unappropriated Balance
05-E-203, Facility Modification for ^{233}U Disposition, ORNL[a]	114,184	0	0	13,509[b]	18,705	81,970

[a] Planning and Design activities performed in FY 2003 and 2004 were funded from budgeted amounts ($9,408,000) for Building 3019 Complex operations as noted in the Preliminary Project Execution Plan (PEP).

[b] Reflects a rescission reduction in the amount of $107,393.

Isotope Production and Distribution Program Fund

Funding Schedule by Activity

No funds are requested for the Isotope Production and Distribution Fund. Isotopes are currently produced and processed at three facilities: LANL, BNL and ORNL. Each of the sites' production expenses associated with processing and distributing isotopes will be offset by revenue generated from sales. See the Radiological Facilities Management section for justification of appropriations request.

Description

The mission of the Department's Medical Isotope Infrastructure program is to maintain the infrastructure required to support the national need for a reliable supply of isotope products, services, and related technology used in medicine, industry, and research.

Benefits

This assures that critical isotope production infrastructure is operated in a safe, secure, environmentally-compliant and cost-effective manner, thus ensuring that the facilities are available to support users who need DOE-produced isotopes. A combination of an appropriation and revenues from isotope sales are deposited in the Isotope Production and Distribution Fund, which is a revolving fund. All isotope production costs are financed by revenues from sales of isotope products and services. The Fund's revenue and expenses are audited annually consistent with Government Auditing Standards and other relevant acts, such as the Chief Financial Officers Act of 1990 and the Government Performance and Results Act of 1993. Included in the Annual Financial Statements and Program Overview are the performance measures results.

The Department has supplied isotopes and related services to the public for more than 50 years. As the range of available isotopes and recognized uses has grown, isotope applications have become vital to continued progress in medical research and practice, new industrial processes, diagnosis, and therapies, which are an indispensable and a growing component of the U.S. health care system. The use of medical isotopes reduces health care costs and improves the quality of patient care.

As the range of available isotopes and the recognized uses for them have increased, new or improved isotope products have become essential for progress in medical research and practice, new industrial processes, and scientific investigation. A substantial national and international infrastructure has been built around the use of isotopes. It is estimated that one in every three people treated at a hospital makes use of a radioisotope in their laboratory tests, diagnoses, or therapy. Each day, over 40,000 medical patients receive nuclear medicine procedures in the United States. Such nuclear procedures are among the safest diagnostic tests available. They save many millions of dollars each year in health care costs and enhance the quality and effectiveness of patient care by avoiding costly exploratory surgery and similar procedures. For example, it has been demonstrated that the use of myocardial perfusion imaging in emergency department chest pain centers can reduce duration of stay on average from 1.9 days to 12 hours with a concomitant reduction in charges. Therefore, an adequate supply of medical and research isotopes is essential to the Nation's health care system, and to basic research and industrial applications that contribute to national economic competitiveness. The Department will continue to make new

capital investments to replace, or enhance processing equipment and infrastructure in order to improve production and processing of isotopes to meet current and anticipated future increases in demand.

The isotopes scheduled for production are based on the Nuclear Energy Protocol for Research Isotopes (NEPRI) process. This protocol serves as a guide for the selection of research isotopes. The process is designed to assure DOE produces those isotopes that will return the most benefit to the research community and general public. Based on comments from researchers, the NEPRI application and review process has been streamlined. Also, a peer-review will be used for the selection of isotopes only when the DOE exceeds production capacity. NEPRI isotopes will be produced as long as sufficient funding commitments are received to cover direct production costs. Each isotope will be priced such that the customer pays its cost of production for that isotope. No Radiological Facilities Management program funds will be expended on the development or production of these isotopes.

The DOE will continue to sell commercial isotopes at full-cost recovery. The list of commercial isotopes will be issued in parallel with the NEPRI list. A portion of revenue from the sales of commercial isotopes contributes to defray facility infrastructure expenses that would otherwise require additional appropriation.

Generally, the program has functioned as a traditional vendor-purchaser relationship as found in any business, *e.g.* billing at the time of shipment and collection in 30 days. Since the annual Radiological Facilities Management appropriations will be restricted to isotope infrastructure expenses, no funds will be available as working capital. Hence, all isotope production costs will be financed by revenue from sales.

05-E-203 - Facility Modifications for ^{233}U Disposition, Oak Ridge National Laboratory, Oak Ridge, Tennessee

(Changes from FY 2005 Congressional Budget Request are denoted with a vertical line [|] in the left margin.)

Significant Changes

Since submittal of the FY 2005 Construction Project Data Sheet (CPDS), this project has been fully integrated with the requirements of DOE Order 413.3, " Program and Project Management for the Acquisition of Capital Assets", including the performance of two External Independent Reviews by the Office of Engineering and Construction Management, in order to ensure that the decision to proceed is based on an accurate cost estimate and classification of costs. The FY 2006 CPDS estimate is based on the design at the 60% completion level. This level of design detail now fully accounts for the actual conditions that exist in this sixty year old facility. Many of these conditions were not known or fully understood at the time of the conceptual estimate. As a result, the construction costs have increased from estimates submitted during the contractor selection process. Final cost estimates will be submitted in conjunction with the request for Critical Decision 2 (CD-2), Approve Performance Baseline, in accordance with DOE Order 413.3 and incorporated into the FY 2007 CPDS.

Following CD-2, Approve Performance Baseline, the final costs will be incorporated into an updated Program Business Case that will be submitted to Congress prior to proceeding with physical modifications in accordance with language contained in conference report of the House and Senate Committees on Appropriations (House Report 107-681). Although the project cost has significantly increased, the Program Business Case should show that the combined design/construction and uranium-233 (U-233) down-blending costs remain a prudent investment for the Department. The Program eliminates a significant liability at the Oak Ridge National Laboratory, mitigates the impact of rapidly increasing security costs associated with the new Design Basis Threat, and projects a cumulative net savings to the Department by 2030 of approximately $265,000,000.

The current Total Estimated Cost (TEC) of the project has increased from $40,134,000 to $114,184,000, an increase of $74,050,000. The TEC increase consists of (1) facility modifications/process equipment increase of $43,630,000 due to a better understanding of existing building conditions, development of additional design details, and Department direction to increase processing capacity; and
(2) reclassification of items previously included in the operating portion of the U-233 Program as project costs (TEC) in the amount of $30,420,000.

The Total Project Cost (TPC) went from $40,134,000 in FY 2005 to $138,923,000 in FY 2006. This includes the $74,050,000 TEC increase noted above and a $24,739,000 increase in "Other Project Costs" due to (1) the cost of reclassifying preliminary design, start up testing and commissioning costs as project costs; and (2) increased start-up and commissioning costs as a result of the mature equipment design.

The costs of implementing new security requirements demanded by the new Design Basis Threat in the post September 11, 2001, era are being evaluated and are not included in this CPDS at this time.

1. Construction Schedule History [a]

	Fiscal Quarter				Total Estimated Cost ($000)	Total Project Cost ($000)
	A-E Work Initiated	A-E Work Completed	Physical Construction Start	Physical Construction Complete		
FY 2005 Budget Request (Preliminary Estimate) [b]	1Q 2004	1Q 2005	1Q 2005	2Q 2007	40,134	40,134
FY 2006 Budget Request (Revised Estimate)[c]	1Q 2004	3Q 2005	3Q 2005	4Q 2008	114,184	138,923

2. Financial Schedule

(dollars in thousands)

Fiscal Year	Appropriations	Obligations	Costs
2005	13,509[d]	13,509	13,509
2006	18,705	18,705	18,705
2007	45,502	45,502	45,502
2008	36,468	36,468	36,468

[a] Planning and Design activities performed in FY 2003 and 2004 were funded from budgeted amounts for Building 3019 Complex operations as noted in the Preliminary Project Execution Plan (PEP) provided to Congress in May 2002. The remaining Planning and Design activities performed in FY 2005 will be funded from line item funding. This is consistent with the FY 2005 appropriation and the intent of DOE Order 413.3.

[b] FY 2005 TEC and TPC data reflected conceptual design estimates.

[c] FY 2006 TEC and TPC data estimates are based upon a 60% design. Prior year planning and design associated with the U-233 program are shown in the "Other Project Cost (OPC)" category. The $74,050,000 increase in TEC indicates a real increase of $43,630,000 and reclassified costs from the program to the project of $30,420,000. The $98,790,000 increase in TPC reflects a real increase of $50,650,000 and reclassified costs from the program to the project in the amount of $48,140,000. TEC/TPC numbers will be finalized for Critical Decision 2, Approve Performance Baseline, as defined in DOE Order 413.3, "Program and Project Management for the Acquisition of Capital Assets". No decisions on construction will be made until the performance baseline is approved by the Department and a revised business plan is submitted to Congress.

[d] Reflects a rescission reduction in the amount of $107,393.

3. Project Description, Justification and Scope

The "^{233}U Disposition, Medical Isotope Production and Building 3019 Complex Shutdown" project has been developed by the Department of Energy (DOE) to meet two major objectives: (1) to increase the availability of medically valuable isotopes by processing the DOE ^{233}U inventory at Oak Ridge; and (2) to resolve legacy safety and security issues associated with the inventory and its storage facility, including the safety issues that were identified by the Defense Nuclear Facilities Safety Board (DNFSB) in Recommendation 97-1, "Safe Storage of Uranium-233". Blending down this material will support National non-proliferation goals by making the material unsuitable for use in weapons and reduce security costs at the Oak Ridge National Laboratory.

The Project will be executed in accordance with the "Report to Congress on the Extraction of Medical Isotopes from Uranium-233**",** submitted to Congress in May 2002. Accordingly, this project will:

- Extract thorium-229 (^{229}Th) for use as a source of medical isotopes to support research and potential treatment (*e.g*., actinium-225 (^{225}Ac)/bismuth-213 (^{213}Bi);.
- Render the entire ^{233}U inventory suitable for safe and economical long-term storage by eliminating nuclear criticality and proliferation concerns, through isotopic down blending with depleted uranium;
- Shutdown the Building 3019 Complex in preparation for final decontamination and decommissioning (D&D); and
- Meet the requirements of DNFSB Recommendation 97-1, which addresses the storage, inspection, and repackaging of the ^{233}U maintained at ORNL.

The Department developed a three-phased approach to allow for systematic decision-making and to increase the Department's flexibility. The base contract award consisted only of Phase I/Planning and Design. On October 9, 2003, a contract was awarded to Isotek Systems, LLC, a limited-liability corporation formed by Duratek Federal Services, Inc., Nuclear Fuel Services, Inc., and Burns and Roe Enterprises, Inc., to perform Phase I of the work. Phase II/Project Implementation and Phase III/Building 3019 Complex Shutdown are contract options that may be unilaterally exercised by the Department.

Completion of the "^{233}U Disposition, Medical Isotope Production and Building 3019 Complex Shutdown" project will save approximately $265 million over a 25 year time period over the cost of continued ^{233}U storage inside Building 3019. The costs of implementing new security requirements demanded by the new Design Basis Threat in the post September 11, 2001, era are being evaluated and are not included in this CPDS at this time**.**

This project data sheet has been revised to include the cost of design activities, building support costs during construction and other project costs, including start-up testing, commissioning, and Operational Readiness Reviews, as recommended by the External Independent Review (EIR) conducted by the Department's Office of Engineering and Construction Management in accordance with DOE Order 413.3, "Program and Project Management for the Acquisition of Capital Assets". This project data sheet addresses the funding requirements and projected schedule for capital improvements to the Building 3019 Complex that are necessary to accomplish program activities of processing (including medical isotope production), repackaging, and removal of the ^{233}U inventory. A more detailed description of each phase is below.

Phase I - Planning and Design:

Phase I will consist of detailed project planning, process and facility modification designs, development of safety documentation, and development of detailed Phase II cost estimates. Phase I will be conducted on a cost-plus-fixed-fee basis. The duration of Phase I has increased from 13 months to 18 months due to re-designing portions of the processing equipment in order to increase their through-put capacity (from 12 kg to 18 kg per week) and to address issues arising from the 60-year-old age of the facility. Concurrently, ORNL will operate the Building 3019 Complex and perform a portion of the ^{233}U container inspection program necessitated by DNFSB Recommendation 97-1.

Phase I, Planning and Design, activities performed in FY 2004 were funded from budgeted amounts for Building 3019 Complex operations as noted in the Preliminary Project Execution Plan (PEP) provided to Congress in May 2002. Critical Decision 1, Approve Preliminary Baseline Range, was approved on May 27, 2004, in accordance with DOE Order 413.3, "Program and Project Management for the Acquisition of Capital Assets". The remaining Phase I, Planning and Design, activities will be completed in FY 2005 using line-item funding.

At the end of Phase I of the project, DOE will determine whether to proceed with Phase II/Project Implementation based on the following:

- The acceptability of the safety analysis, security plan, management plans and final design;
- The acceptability of the detailed cost estimate to complete the project, as determined by an independent cost analysis ("should cost analysis") by DOE using the contractor's design and processing approach;
- The overall performance of the contractor in meeting the DOE cost, schedule, and safety requirements; and
- A National Environmental Policy Act (NEPA) review of the proposed action.

The Department's Office of Engineering and Construction Management will review and validate the "should cost analysis." Based on the evaluation of the work conducted under Phase I of the project (deliverables, contractor performance, and project costs) and the NEPA review, DOE can choose either to terminate the project or unilaterally exercise the option to implement Phase II.

Phase II - Project Implementation

During Phase II, the contractor would begin the necessary capital construction improvements (facility modifications and processing equipment installation plus contingency) estimated at $107,297,000. Total estimated cost and total project cost data reflect estimates for Phase I design costs and Phase II capital improvements to the Building 3019 Complex costs and are based on the estimates from the design at the 60% completion level and reflect adjustments made in response to the External Independent Review. These numbers will be updated during Phase I of the contract in conjunction with Critical Decision 2, Approve Performance Baseline, as defined in DOE Order 413.3, "Program and Project Management for the Acquisition of Capital Assets". Following the completion of the capital construction improvements, the contractor would begin the program activities of ^{229}Th extraction while down-blending the enriched ^{233}U with depleted uranium, and shipment of approximately 1,000 to 1,100 containers of down-blended material to an approved interim storage location at Oak Ridge. Execution of the program activities during Phase II would satisfy all of the requirements

of the inspection and repackaging program that DOE agreed is necessary to resolve DNFSB Recommendation 97-1.

During Phase II, the contractor would also be responsible for operation of the Building 3019 Complex, including the characterization, packaging, transportation and disposal of secondary wastes (*e.g.*, personal protection equipment, construction debris, liquid residues, etc.)

The extracted ^{229}Th, in conjunction with existing quantities of purified ^{229}Th, would be leased to the contractor if DOE proceeds with Phase II of the project. The lease would require transportation of ^{229}Th to the lessee's commercial facility, storage and processing of the leased ^{229}Th to extract ^{225}Ac, the marketing, sale, and distribution of ^{225}Ac for medical research and treatment, and continued supply of the DOE existing ^{225}Ac customers. All activities under the lease would be at no cost to the Government.

During Phase II, the contractor would also be required to develop transition plans to place the Building 3019 Complex in a safe and stable shutdown configuration prior to transfer to the DOE decommissioning program. The contractor would also be required to develop a post-transition surveillance and maintenance plan. These plans would ensure that any contamination present is adequately contained, and that potential hazards to workers, the public, and the environment are minimized and controlled.

Upon completion of Phase II/Project Implementation processing activities, the contractor would be required to clean up all processing systems and equipment, including the removal and disposal of unattached solid waste materials and residual process materials in accordance with criteria specified by DOE. After clean-up has been completed, the contractor would characterize these systems and equipment and provide the characterization data to DOE. The redesigned throughput capacity noted in Phase I above reduced the duration of Phase II from 84 months to 78 months.

Phase III - Building 3019 Complex Shutdown

Phase III would consist of performance of facility stabilization and transition activities to meet the criteria for transferring the facility to the Department's Office of Environmental Management (EM) program for decommissioning. The estimated duration of Phase III is 6 months.

4. Details of Cost Estimate

(dollars in thousands)

	Current Estimate	Previous Estimate
Design Phase		
Planning and Design Costs (includes Design and Project Management costs)(6.0% of TEC)	6,887	n/a[a]
Total, Design Phase	6,887	n/a
Project Implementation		
Facility Modifications/Process Equipment (55.8% of TEC)	63,740	32,924
Building Support Costs During Construction (25.0% of TEC)	28,519	0
Project Management (7.3% of TEC)	8,298	1,975
Total, Project Implementation	100,557	34,899
Contingency (5.9% of TEC)	6,740	5,235
Total Line Item Cost	114,184	40,134
Less: Non-Agency Contribution	0	0
Total, Line Item Costs (TEC)[b]	114,184	40,134

5. Method of Performance

The DOE Oak Ridge Operations Office (ORO) will be responsible for implementation of the ^{233}U project (including selection of principal contractor) and approval of specified procurement actions. Project deliverables will be performed under a negotiated contract which will be awarded on the basis of competitive bidding. The selected contractor will manage the project. A dedicated Federal project manager at ORO will oversee the efforts of the selected contractor.

a Phase I, Planning and Design, activities performed in FY 2004 were funded from budgeted amounts for Building 3019 Complex operations as noted in the Preliminary Project Execution Plan (PEP) provided to Congress in May 2002.

b Based on recommendations from the External Independent Review conducted by the Office of Engineering and Construction Management, the FY 2006 TEC and TPC has been revised to include Phase I, Planning and Design, costs and Other Project Costs previously budgeted for the Uranium-233 Program account, as well as cost estimates based on the design at the 60% completion level. TEC/TPC numbers will be finalized for Critical Decision 2, Approve Performance Baseline, as defined in DOE Order 413.3, Program and Project Management for the Acquisition of Capital Assets

6. Schedule of Project Funding

(dollars in thousands)

	Prior Years	FY 2005	FY 2006	Outyears	Total
Project Cost					
Facility Cost					
Planning and Design	0	6,887	0	0	6,887
Project Implementation	0	6,622	18,705	81,970	107,297
Total, Line item TEC	0	13,509	18,705	81,970	114,184
Other project costs					
Conceptual Design costs[a]	9,408	0	0	0	9,408
NEPA documentation costs	100	0	0	0	100
Other project-related costs	715	0	0	14,516	15,231
Total other project costs	10,223	0	0	14,516	24,739
Total, Project Cost (TPC)	10,223	13,509	18,705	96,486	138,923

7. Related Annual Funding Requirements

	Current Estimate	Previous Estimate
Facility operating costs	*	*

*Narrative Explanation of Related Annual Funding Requirements

The Total Estimated Cost (TEC) and Total Project Cost (TPC) address only the facility modifications and procurement and installation of processing equipment necessary to begin the program activities of ^{229}Th extraction and uranium down-blending in the Building 3019 Complex. The majority of the programmatic costs are related to down blending operations and baseline security costs that will be required from award of Phase I to shutdown of the Building 3019 Complex during Phase III. The total funding estimate for all phases including these related annual funding requirements was approximately $250,000,000 based on the Preliminary PEP provided to Congress in May 2002. The total funding estimate, including the Annual Funding requirements, will be updated in a revised Business Case as requested by the House and Senate Committees on Appropriations (House Report 107-681) prior to award of Phase II of the contract. The revised Business Case will incorporate updated Total Project Cost data, costs associated with down blending and storage and security costs associated with the implementation of the new Design Basis Threat. These costs will be compared against the updated costs for continued storage of the ^{233}U in Building 3019 at the Oak Ridge National Laboratory.

a Planning and Design activities performed in FY 2003 and 2004 were funded from budgeted amounts for Building 3019 Complex operations as noted in the Preliminary Project Execution Plan (PEP) provided to Congress in May 2002.

Idaho Facilities Management

Funding Schedule by Activity

(dollars in thousands)

	FY 2004	FY 2005	FY 2006	$ Change	% Change
Idaho Facilities Management					
INL Operations	73,120	110,642	86,907	-23,735	-21.5%
INL Construction	2,295	1,511	10,955	+ 9,444	+625.0%
Total, Idaho Facilities Management	75,415	112,153	97,862	-14,291	-12.7%

Funding Schedule by Activity – Energy Supply

(dollars in thousands)

	FY 2004	FY 2005	FY 2006	$ Change	% Change
Idaho Facilities Management – Energy Supply					
INL Operations	51,824	89,923	69,145	-20,778	-23.1%
INL Construction	2,295	1,511	10,955	+9,444	+625.0%
Total, Idaho Facilities Management – Energy Supply	54,119	91,434	80,100	-11,334	-12.4%

Funding Schedule by Activity – Other Defense Activities

(dollars in thousands)

	FY 2004	FY 2005	FY 2006	$ Change	% Change
Idaho Facilities Management – Other Defense Activities					
INL Operations	21,296	20,719	17,762	-2,957	-14.3%
Total, Idaho Facilities Management – Other Defense Activities	21,296	20,719	17,762	-2,957	-14.3%

Description

Beginning in the second quarter of FY 2005, the research portion of the Idaho National Engineering and Environmental Laboratory will be merged with Argonne National Laboratory - West (ANL-W) to form the basis of the Idaho National Laboratory (INL). The INL is a multi-program national laboratory that employs its research and development assets to pursue assigned roles in a range of research and national security activities.

The purpose of the Idaho Facilities Management program is to provide the INL with the site-wide Landlord infrastructure required to support technical efforts such as research on the Advanced Fuel Cycle Initiative, Generation IV nuclear energy systems, the Space and Defense Power Systems program, and the Navy's nuclear propulsion research and development program.

Benefits

The Idaho Facilities Management program supports "National Energy Policy" goals by maintaining and operating important INL basic infrastructure that is required to support facilities dedicated to advanced nuclear energy technology research and many other Federal government activities. As the landlord of the INL, the Office of Nuclear Energy, Science and Technology (NE) manages common-use equipment, facilities, land, and support services that are not directly funded by programs. Key activities conducted under these programs include assuring that all landlord facilities meet essential safety and environmental requirements and are maintained, managing all special nuclear materials contained in these facilities, and the disposition of DOE legacy waste materials under NE ownership.

To address the requirements to support the missions at INL, NE has developed an INL Ten-Year Site Plan that presents a mission needs analysis of existing facilities and infrastructure and clearly identifies the investments needed at the site to support its projected mission profile. The Plan provides recommendations for short- and long-term recapitalization of existing mission essential facilities and infrastructure and presents a plan to upgrade laboratory facilities to support emerging and growing laboratory missions such as the Advanced Fuel Cycle Initiative, the Generation IV Nuclear Energy Systems Initiative, and a range of national security technology programs. The Plan identifies and prioritizes the projects, activities, and mission resource requirements for real property assets that cover a ten-year planning horizon.

The Plan includes a prioritized listing of maintenance, repair and recapitalization projects necessary to correct the maintenance backlog. The Plan is organized to assure the maintenance backlog is stabilized by 2007, and reduced to the industry benchmark of 2%-4% of Replacement Plant Value by 2013. The use of this industry benchmark was recommended by the National Research Council's Congressionally-sponsored 1998 study Stewardship of Federal Facilities. The Plan describes how NE could recapitalize INL, acquire new facilities, infrastructure systems and equipment, and dispose of facilities no longer needed. The Plan is the product of the detailed INL planning process and provides performance measures to show how the physical state of the complex is expected to change over time. The FY 2006 budget request has been based on this Plan. The Plan will be updated annually to reflect new program and infrastructure requirements as they emerge.

Detailed Justification

(dollars in thousands)

	FY 2004	FY 2005	FY 2006
INL Operations	**73,120**	**110,642**	**86,907**
▪ **Laboratory Transition and Restructuring**	**0**	**43,453**	**0**

The $43.8M requested for FY 2005 was intended to cover the one-time costs associated with workforce restructuring as the Idaho National Engineering and Environmental Laboratory contract was divided into separate laboratory and clean-up contracts. All restructuring associated with the establishment of the INL will be complete in FY 2005.

▪ **Infrastructure Operations** **52,319** **55,303** **64,582**

Manage the operation of common use and user facilities at the INL, including operating and maintaining nuclear and radiological facilities, ensuring environmental compliance, and providing infrastructure program management and support for planning, managing, and administering the Idaho Facilities Management Program. The infrastructure includes 890 square miles of land, 298 buildings, associated support structures, a full complement of utilities, including communication and data transmission systems, approximately 800 miles of roads, 61 miles of electrical transmission lines and 14 miles of railroad lines. Operating activities include grounds inspection and maintenance; inactive facilities surveillance and maintenance; excess facility decommissioning and disposition; disposition of legacy materials at an off-site commercial facility; and general plant project, capital equipment, and line item projects. Management also includes various crosscutting contracts and obligations between the Department of Energy and other entities including the National Oceanic and Atmospheric Administration, the Shoshone and Bannock Indian Tribes, the State of Idaho, and payments in lieu of taxes for the four counties in which the INL is located.

The Advanced Test Reactor (ATR) is essential to ongoing and planned national security and energy research programs at the Idaho National Laboratory. Independent review teams of industry experts have found that ATR required engineering analysis, increased maintenance, and recapitalization of systems to remain a viable research tool for the next thirty to forty years. The current estimated incremental cost of repairs and upgrades is about $200 million dollars over a ten year period. This is a prudent investment since the replacement value of the reactor is about $2 billion dollars. This review prompted several projects, most notably an exhaustive Design Basis reconstitution. This project is in progress and results to date are favorable. In FY 2006 work should be complete on a Design Basis reconstitution that will verify the reactor meets modern nuclear safety standards. The recommendations of this review and other analyses will be incorporated into an INL Ten Year Site Plan (TYSP). This plan, updated annually, is the foundation for INL facilities and infrastructure strategic planning and the cornerstone of the Program's initiative to restore the INL and the facilities on the site. The INL TYSP is requirements based and clearly demonstrates the results that will be accomplished for the resources expended, consistent with the President's Management Agenda (PMA) and NE's performance and budget integration initiative. Specifically, the TYSP includes a prioritized list of recapitalization projects that is based upon a formal prioritization methodology that preferentially targets deferred maintenance reduction, particularly for mission-essential facilities and infrastructure. As a result, the FY 2006 Idaho Facilities Management budget request includes an

(dollars in thousands)

FY 2004	FY 2005	FY 2006

increase of $12.1 million in operations and maintenance. In FY 2006 there will be significant progress in developing a long term operating plan that will validate maintenance, staffing, and recapitalization needs. A long term analysis of fuel and beryllium components will also be completed to support long term requirement plans. Small-dollar-value projects, equipment, and critical component purchases will also be funded as they are identified in the long term operating plan.

- **IT Investments** **0** **0** **4,400**

The IT Investments includes activities such as:

Network Infrastructure Improvements: Provide the connectivity at INL required to facilitate engineering and research under the NE and national security mission areas. The INL network infrastructure supporting mission research and engineering is of minimal capacity. The 1 Gigabyte switches currently in place to control traffic between the engineering research buildings at the laboratory are insufficient for High Performance Computing (HPC). Implementation of a new HPC computing capability will further impact network capacities. Additionally, connectivity to off-site should be improved to facilitate collaborative research and file transfer between other DOE complex labs involved in the mission research. ($1.6M)

Engineering Workstation Replacements: Provide replacement of engineering workstations infrastructure in the R&D lead mission areas with state-of-the-art equipment, and provide follow-on budget in subsequent fiscal years, to support a shortened lifecycle (3 Year) infrastructure replacement program. The Engineering and Research workstations investment at the lab has had machine life-cycle timetables extended to well beyond the 5 year time frame over the last decade. Currently 2/3 of the engineering workstation assets are 5 years or older - with approximately 20% being in excess of 10 years old. ($1.3M)

High Performance Computing: Conduct a detailed computational infrastructure assessment and High Performance Computing strategy for the new INL. ($1.5M)

- **General Plant Projects** **10,637** **9,033** **8,907**

The GPP budget line includes projects such as:

- The Minimum Safe/Caretaker Upgrades Project - Most of the site infrastructure is 30 to 50 years old. Historically, between budget submission and the budget execution year, urgent infrastructure maintenance needs emerge that were not planned on. These problems typically pose a risk to the employees, the public or the environment or impact the ability of the site to meet its mission objectives. This annual project sets aside funds to address these unanticipated urgent infrastructure-related environment, safety, and health problems.

(dollars in thousands)

FY 2004	FY 2005	FY 2006

- ATR Emergency Injection System Upgrade – ATR emergency core cooling water is currently supplied by the Test Reactor Area (TRA) site-wide firewater system. To meet new safety standards for the firewater emergency core cooling, the proposed modification and upgrade to the Emergency Core Cooling System (ECCS) will create a dedicated firewater system for ATR that is independent of the existing TRA firewater supply system. FY 2006 funding will be used to complete design and fabrication of the ATR Emergency Injection System Upgrade to meet new safety standards.

- Diesel Generator Feed to Deep Well Pump #4 – The deep well pumps supply site water, including firewater. Firewater is used for emergency cooling. All deep well pumps are supplied from commercial power. The design basis reconstitution project has identified lack of a diesel backup power supply as a vulnerability that results in increased risk assumed by DOE in the approved Safety Analysis Report for ATR.

- **Capital Equipment** **5,395** **2,853** **9,018**

  Purchase equipment in accordance with the "INL Ten Year Site Plan". Much of the equipment currently in use at the INL is 30 to 50 years and failing. In many cases, replacement parts are unavailable from vendor stock and must be custom manufactured. This funding primarily provides upgrades and replacements for aged, deteriorated equipment and procurement of new equipment to meet emerging requirements. This includes such things as: shop and miscellaneous maintenance equipment, vehicles and heavy equipment, additional oscilloscopes, bandwidth capacity network upgrades and instrumentation/hardware.

  Funding also provides for beginning replacement of ATR's five primary heat exchangers. Existing heat exchangers are more than 40 years old and are approaching the end of their useful life. The carbon steel shells of the heat exchangers exhibit pit corrosion so far resulting in one leak requiring shut down of the reactor for repair. General corrosion has reduced wall thickness of the heat exchangers to the extent that replacement is now required. Failure of one or more of the five heat exchangers would severely impact the ability of the ATR to accomplish its mission.

- **Gas Test Loop Upgrade at the Advanced Test Reactor** **4,769** **0** **0**

  This upgrade will provide for the design, fabrication, assembly, start-up testing, and installation of a gas test loop assembly in the Advanced Test Reactor. Using FY 2004 funds, final preparation of pre-conceptual documentation for Critical Decision 0, "Approval of Mission Need" was completed on June 30, 2004. Project Engineering and Design (PED) funds are being requested through a PED datasheet (06-E-200) in FY 2006 to start preliminary design for the project. See the item, "06-E-200, Nuclear Energy Project Engineering and Design" under *INL Construction*, below.

(dollars in thousands)

	FY 2004	FY 2005	FY 2006
INL Construction	**2,295**	**1,511**	**10,955**
▪ **95-E-201, TRA Fire & Life Safety Improvements**	**490**	**0**	**0**

The highest priority remaining work scope will be completed in FY 2004 and the project closed out in FY 2005 using prior year funds.

▪ **99-E-201, TRA Electrical Utility Upgrade**	**1,805**	**1,511**	**0**

Complete the TRA Electrical Utility Upgrade Line Item Capital Project, which replaces most of the obsolete TRA high voltage electrical distribution system that had become inadequate for current tenant needs and unreliable due to age and dwindling availability of spare parts.

▪ **06-E-200, Nuclear Energy Project Engineering and Design**	**0**	**0**	**7,870**

- PED funding for the Gas Test Loop in the Advanced Test Reactor project will provide for the design and construction of a gas test loop to support the irradiation testing requirements of the Generation IV and Advanced Fuel Cycle Initiative Programs. Funding in FY 2006 provides for acceleration of the Architect-Engineering services for preliminary engineering design; final design and project management on this project. ($4.7M)
- PED funding for the Remote Treatment Project provides infrastructure necessary to carry out the near-term waste management needs stemming from the nuclear research legacy at the Idaho National Laboratory. This project would be designed to characterize, segregate, treat, repackage, and ship remote-handled wastes. Funding in FY 2006 will be used to proceed with Title I design. ($3.1M)

▪ **06-E-201, Gas Test Loop in the Advanced Test Reactor (ATR)**	**0**	**0**	**3,085**

This project will provide for a unique Gas Test Loop in the ATR to support the irradiation testing requirements of the Generation IV Reactor and Advanced Fuel Cycle Initiative Programs. This new facility in ATR will be a significant contributor to the accomplishment of the Department's new strategic nuclear energy mission for the Idaho National Laboratory. Funds were provided in FY 2004 for final preparation of pre-conceptual documentation for Critical Decision 0, "Approval of Mission Need" which was completed on June 30, 2004. Funding in FY 2006 will be used for initiation of construction activities including procurement of long lead items.

Total, Idaho Facilities Management	**75,415**	**112,153**	**97,862**

Explanation of Funding Changes

	FY 2006 vs. FY 2005 ($000)
INL Operations	
▪ **Laboratory Transition and Restructuring**	
The decrease of $43,453,000 reflects one-time costs in FY 2005 associated with restructuring the Idaho laboratory complex and supporting site infrastructure services.	-43,453
▪ **Infrastructure Operations**	
In working towards the goal of achieving and maintaining an expenditure rate of 2-4 percent of Replacement Plant Value, a level recommended by the National Academy of Sciences, for the facilities at INL, an increase of $9,279,000 is required to baseline routine maintenance and repair in FY 2006. This funding increase will also support an independent review team's recommendation to increase maintenance and recapitalization systems at the ATR, by the development of a long range operating plan for the ATR and by addressing small projects, equipment, and critical component purchases as they are identified in the plan. These increases are consistent with the prioritized list projects established in the Ten Year Site Plan that preferentially targets deferred maintenance reduction, particularly for mission-essential facilities and infrastructure.	+9,279
▪ **IT Investments**	
Consistent with the new mission of the INL to become the center for the Department's strategic nuclear energy research and development efforts, an increase of $4,400,000 reflects Network Infrastructure Improvements; Engineering Workstation Replacements; and High Performance Computing to support the national security and energy research programs	+4,400
▪ **General Plant Projects**	
Consistent with the prioritized list of recapitalization projects identified in the Ten Year Site Plan to achieve and maintain an expenditure rate of 2-4 percent of Replacement Plant Value, a decrease of $126,000 is required for facility upgrades	-126
▪ **Capital Equipment**	
Consistent with the prioritized list of recapitalization projects identified in the Ten Year Site Plan to achieve and maintain an expenditure rate of 2 to 4 percent of Replacement Plant Value, an increase of $6,165,000 is due to installation of a diesel generator backup power source for deep well pump #1	+6,165
Total, INL Operations	**-23,735**

	FY 2006 vs. FY 2005 ($000)
INL Construction	
▪ **99-E-200, TRA Electrical Utility Upgrade**	
The decrease of $1,511,000 reflects completion of the project in FY 2005 in accordance with the project plan	-1,511
▪ **06-E-200, Nuclear Energy Project Engineering and Design**	
Consistent with the regulatory requirements and the advanced experimental capabilities associated with the new nuclear energy missions at INL identified in the Ten Year Site Plan, the increase of $7,870,000 supports Architect-Engineering services for preliminary and final engineering design and project management for the Remote Treatment Project and the Gas Test Loop in the ATR	+7,870
▪ **06-E-201, Gas Test Loop in the Advanced Test Reactor**	
The increase of $3,085,000 will be used for initiation of construction activities including procurement of long lead items...	+3,085
Total, INL Construction	**+9,444**
Total Funding Change, Idaho Facilities Management	**-14,291**

Capital Operating Expenses

(dollars in thousands)

	FY 2004	FY 2005	FY 2006	$ Change	% Change
Capital Equipment	5,395	2,853	9,018	+6,165	+216.1%
General Plant Projects/ANL-W General Site Upgrades	10,637	9,033	8,907	-126	-1.4%
Total, Capital Operating Expenses	16,032	11,886	17,925	+6,039	+50.8%

Construction Projects

(dollars in thousands)

	Total Estimated Cost (TEC)	Prior-Year Appropriation	FY 2004	FY 2005	FY 2006	Unappropriated Balance
06-E-201, Gas Test Loop in the Advanced Test Reactor, Idaho	22,400	0	0	0	3,085	19,315
06-E-200, Nuclear Energy Project Engineering and Design. Idaho	32,070	0	0	0	7,870	24,200
95-E-201, TRA Fire & Life Safety Improvements Project, Idaho	14,768	14,278	490	0	0	0
99-E-200, TRA Electrical Utility Upgrade, Idaho	7,720	4,404	1,805	1,511	0	0
Total, Construction			2,295	1,511	10,955	

06-E-200, Nuclear Energy, Project Engineering and Design (PED), Idaho National Laboratory (INL), Idaho

Significant Changes

None

1. Construction Schedule

	Fiscal Quarter				Total Estimated Cost (Design Only) ($000)
	A-E Work Initiated	A-E Work Completed	Physical Construction Start	Physical Construction Complete	
FY 2006 Budget Request (*Preliminary and Final Design Only*).....	1Q 2006	3Q 2007	N/A	N/A	32,070

2. Financial Schedule

(dollars in thousands)

Fiscal Year	Appropriations	Obligations	Costs
2006	7,870	7,870	7,870
2007	16,900	16,900	15,900
2008	7,100	7,100	7,600
2009	200	200	700

3. Project Description, Justification and Scope

This construction project data sheet summarizes the Nuclear Energy requirements for architect-engineering services for Preliminary and Final Design for one subproject, Gas Test Loop 06-02. This data sheet also outlines one subproject which will be proceeding from conceptual design into Title I and Title II design, Remote Treatment Project 06-02. The design effort will be sufficient to assure project feasibility, define the scope, provide detailed estimates of construction costs based on the approved design and working drawings and specifications, and provide construction schedules including procurements.

Conceptual design studies are prepared for each project using operations and maintenance funds prior to receiving design funding under a PED line item. These conceptual design studies define the scope of the project and produce a rough cost estimate and schedule.

The use of project engineering and design funds will: 1) enable a project to proceed immediately upon completion of the conceptual design into Title I and Title II designs because only the design funds are requested; 2) provide a range for the construction cost and schedule; 3) permit acceleration of new facility projects, providing savings in construction costs based on current rates of inflation; and 4) permit more mature cost, schedule, and technical baselines for projects when the construction funds are requested from the Congress.

Following completion of preliminary design activities, Nuclear Energy personnel will determine preliminary project baselines and provide detailed funding and schedule estimates for physical construction and procurements. At completion of the preliminary design, the Department's Office of Engineering and Construction Management will provide external independent reviews of the project requirements, scope, schedule, cost and budget. Based upon the results of this assessment, and a review of the continuing programmatic requirement for the project, the acquisition executive will either approve the project baseline and authorize proceeding, defer the project or cancel the project.

The project baseline will be the basis for the request to Congress for authorization and appropriations for physical construction and procurement. The request will identify the project baseline and provide the acquisition executive approval to proceed with final design. For certain projects, in order to meet project schedules, construction and/or procurement activities may be required in the same year as the final design, Project Baseline, and Acquisition Executive approval is completed. For those projects, a report will be provided by, the Office of Engineering and Construction Management, to Congress with the results of preliminary design, project baseline, external independent reviews, and acquisition executive approval. Long-lead project and/or construction start will not proceed until 30 days after the report has been submitted to Congress. Each project that proceeds to physical construction will be separated into an individual construction line item, the total estimated cost of which will identify the costs of the engineering and design activities funded through the project engineering and design account.

4. Details of Cost Estimate

(dollars in thousands)

	Current Estimate	Previous Estimate
Design Phase		
Preliminary Design Costs	12,763	0
Final Design Costs	14,281	0
Preliminary Design Management Costs	693	0
Final Design Management Costs	736	0
Project Management (Preliminary Design) Costs	1,030	0
Project Management (Final Design) Costs	1,331	0
Total Design Costs	30,834	0
Design Contingency (Title I & Title II)	1,236	0
Total Design Costs	32,070	0

5. Method of Performance

Please refer to the individual subprojects for contract strategies.

6. Schedule of Project Funding

(dollars in thousands)

	Prior Years	FY 2004	FY 2005	FY 2006	Out years	Total
Facility Design Cost						
Preliminary Design	0	0	0	4,400	8,700	13,100
Final Design	0	0	0	1,594	13,100	14,694
Project & Design Management...	0	0	0	1,876	2,400	4,276
Total PED	0	0	0	7,870	24,200	32,070
Other Project Costs						
Conceptual Design Cost	610	707	8,214	0	0	9,531
NEPA Documentation Costs	50	50	0	0	0	100
Other Project-Related Costs	860	338	0	2,000	0	3,198
Total Other Project Costs	1,520	1,095	8,214	2,000	0	12,829
Total PED and Other Project Costs	1,520	1,095	8,214	9,870	24,200	44,899

FY 2006 Proposed Design Subprojects

Subproject 06-01, Gas Test Loop in the Advanced Test Reactor, Idaho National Laboratory, Idaho

Fiscal Quarter				Total Estimated Cost Design Only) ($000)	Full Total Estimated Cost Projection ($000)
A-E Work Initiated	A-E Work Completed	Physical Construction Start	Physical Construction Complete		
1Q 2006	4Q 2006	1Q 2007	2Q 2008	4,770	22,400

Fiscal Year	Appropriations	Obligations	Costs
2006	4,770	4,770	4,770

The Gas Test Loop in the Advanced Test Reactor (ATR) will provide for the design and construction of a gas test loop to support the irradiation testing requirements of the Generation IV Nuclear Energy Systems Initiative (Gen IV) and Advanced Fuel Cycle Initiative (AFCI) programs. This project is managed under the Idaho National Laboratory (INL) Nuclear Energy program.

The Department of Energy has initiated programs to help revitalize nuclear power generation growth in the United States, in support of the *National Energy Policy* (NEP). Two important programs to help implement the NEP are the Gen IV and AFCI. The programmatic goals are designed to stimulate research and development related to advanced reactor concepts and fuel cycles over the next 30 years.

Part of the Gen IV and AFCI programs focus is directed toward technologies that can reduce the commercial spent fuel burden on both the repository and the environment. In particular, one primary

goal is the reduction and elimination of long-lived transuranic elements contained in commercial spent nuclear fuel. The neutron spectrum characteristic of fast reactors provides the most efficient way to transmute these highly toxic materials.

Transmutation and fission of these long-lived transuranic actinides into shorter-lived fission products has revived interest in fast spectrum irradiation testing of new transmuter fuels and materials. In order to assess the fuel performance of these candidate reactor fuels, such as the minor actinide fuel concentrates, these fuels must be irradiated under actual or prototypical fast reactor flux intensities and energy spectral characteristics. Unfortunately, there are no fast reactors or fast flux test facilities in the United States. These tests cannot be performed without the construction of a Gas Test Loop in the ATR.

Compliance with Project Management Order

- Critical Decision – 0: Mission Need completed June 30, 2004
- Critical Decision – 1: Conceptual Design/Preliminary Baseline September 2005
- Critical Decision – 2: Planned for March 2006
- Critical Decision – 3: Planned for September 2006
- External Independent Review: Planned for 3rd quarter 2005

4. Details of Cost Estimate

(dollars in thousands)

	Current Estimate	Previous Estimate
Design Phase		
Preliminary Design Costs (Design Drawings and Specifications)(4.3% of TEC)	963	0
Final Design Costs (Design Drawings and Specifications)(5.3% of TEC)	1,181	0
Preliminary Design Management[a] Costs (0.9% of TEC)	193	0
Final Design Management Costs (1.1% of TEC)	236	0
Project Management[b] (Preliminary Design) Costs (1.9% of TEC)	430	0
Project Management (Final Design) Costs (2.4% of TEC)	531	0
Total Design Costs (15.8% of TEC)	3,534	0
Design Contingency (Title I & Title II) (5.5% of TEC)	1,236	0
Total Design Costs (21.3% of TEC)	4,770	0

[a] Design Management consists of oversight and control of design activities, not the actual design costs.
[b] Project management includes activities for the project manager, design reviews, project document control, project manager supervision, cost estimating and conduct of operations.

5. Method of Performance

Design engineering will be performed utilizing INL engineering resources where feasible. If required, additional services will be obtained through competitive bid, cost-reimbursable subcontracts.

6. Schedule of Project Funding[a]

(dollars in thousands)

	FY 2004	FY 2005	FY 2006	Outyears	Total
Facility Design Cost					
Preliminary Design	0	0	1,300	0	1,300
Final Design	0	0	1,594	0	1,594
Project & Design Management...	0	0	1,876	0	1,876
Total PED	0	0	4,770	0	4,770
Other Project Costs					
Conceptual Design Cost	207	6,214	0	0	6,421
NEPA Documentation Costs	0	0	0	0	0
Other Project-Related Costs	338	0	2,000	0	2,338
Total Other Project Costs	545	6,214	2,000	0	8,759
Total PED and Other Project Costs	545	6,214	6,770	0	13,529

Subproject 06-02, Remote Treatment Project, Idaho National Laboratory, Idaho

Preliminary Design Fiscal Quarter				Total Estimated Cost (Prelim. Design Only) ($000)	Full Total Estimated Cost Projection ($000)
A-E and Support Work Initiated	A-E and Support Work Completed	Physical Construction Start	Physical Construction Complete		
1Q 2006	2Q 2007	1Q 2008	2Q 2010	12,900	92,700

Fiscal Year	Appropriations	Obligations	Costs
2006	3,100	3,100	3,100
2007	9,800	9,800	9,800

[a] This schedule reflects planned cash flow, not funding (appropriations), costs and other project costs supporting the Title I and Title II and FY 2005 Congressional earmark operating funds of up to $2,000,000 appropriated to Naval Reactors.

Final Design Fiscal Quarter				Total Estimated Cost (Final Design Only) ($000)	Full Total Estimated Cost Projection Range ($000)
A-E and Support Work Initiated	A-E and Support Work Completed	Physical Construction Start	Physical Construction Complete		
4Q 2006	3Q 2007	1Q 2008	2Q 2010	14,400	92,700

Fiscal Year	Appropriations	Obligations	Costs
2007	7,100	7,100	6,100
2008	7,100	7,100	7,600
2009	200	200	700

The Remote Treatment Project (RTP) is required to provide the infrastructure necessary to address waste management legacies arising from past nuclear research activities at the Idaho Site, as agreed between the Department and the State of Idaho. Meeting the Departments legacy waste management commitments and priorities requires the use of a facility in which the remote handling and treatment of highly radioactive materials may be conducted.

The current RTP facility is currently conceived as an annex to the Hot Fuel Examination Facility, consisting of a 28,000 ft^2, four-level facility built around a 56 ft long by 22 ft wide x 31 ft high air atmosphere hot cell. The hot cell would employ fourteen radiation-shielded work station windows with a set of sealed remote manipulators at each window, two floor penetrations and a roof hatch. To provide adequate safety from expected radiation levels, walls, roof, and sections of the air cell floor would be constructed of four foot thick high density concrete. The air cell would be designed to accommodate remote installation and repair of all process equipment. The RTP would also provide for design, fabrication, and installation of all required hot cell waste processing equipment as well as completion of all necessary activities to bring the facility to operational status.

Because the RTP facility is an annex to existing hot cell facilities at the INL, it would minimize capital expenditures by sharing existing infrastructure and capability. It would also integrate existing support capabilities, such as analytic chemistry laboratories, into its operation.

Over the years various DOE-sponsored programs undertaken at INL have produced radioactive wastes and other materials that are classified as remote-handled. These materials include Spent Nuclear Fuel (SNF), transuranic (TRU) waste, waste requiring geological disposal, mixed waste, and radioactively-contaminated reactor components. They were packaged and are presently stored at the Radioactive Scrap and Waste Facility (RSWF) at INL (349 cubic meters). There are other program remote handled (RH) legacy wastes (482 cubic meters) that may need processing in the RTP at the INL's Radioactive Waste Management Complex (RWMC), these waste streams also fall under the 2018 Site Treatment Plan and Settlement Agreement milestones. Portions of, or that entire waste stream could be processed through the RTP under a work-for-others agreement wherein the appropriate capital and operating costs would be charged for any services provided. The current design and scope of the RTP are for the worst-case RH waste (highest radioactivity) currently stored at the RSWF. No RTP design changes would be required to deal with any other program RH waste mentioned if it were decided and

agreed by the program parties to include those wastes in the current RTP characterization, treatment and repackaging campaign.

The RTP would be designed to characterize, segregate, treat, repackage, and ship these RH wastes, as required by the RSWF RCRA permit, the INL Site Treatment Plan Consent Order, and the 1995 DOE/State of Idaho Settlement Agreement on TRU waste and spent fuel management. Characterization and treatment of mixed waste is required to ensure compliance with the Resource Conservation and Recovery Act (RCRA) storage permits, the Federal Facility Compliance Act and the RCRA Land Disposal Restriction (LDR) requirements. Characterization, treatment and repackaging are also required for licensed transportation of this waste. Following appropriate characterization, processing, and treatment, the wastes would be shipped out of Idaho to a designated DOE permanent disposal site.

Compliance with Project Management Order

- Critical Decision – 0: Completed December 2000
- Critical Decision – 1: Conceptual Design/Preliminary Baseline - Completed December 2004
- Critical Decision – 2: Planned for June 2006
- Critical Decision – 3: Planned for July 2007
- External Independent Review: Planned for March 2006

4. Details of Cost Estimate

(dollars in thousands)

	Current Estimate	Previous Estimate
Design Phase		
Preliminary Design Costs (Design Drawings and Specifications)	11,800	0
Final Design Costs (Design Drawings and Specifications)	13,100	0
Preliminary Design Management Costs (0.6% of TEC)	500	0
Final Design Management Costs (0.6% of TEC)	500	0
Project Management (Preliminary Design) Costs (0.7% of TEC)	600	0
Project Management (Final Design) Costs (0.9% of TEC)	800	0
Total Design Costs	27,300	0

(These Costs are based on compound escalation of 20.6% and 85% confidence level contingency of 23.9%) Escalation was compounded, commencing in FY2002 (when the original cost estimate was performed) from "Escalation Rate Assumptions, January 2004", obtained from the OECM web site.) The compounded escalation was applied over the duration of the design activity.

5. Method of Performance

Facility engineering and design will be performed under a negotiated A-E contract with guidance, review and monitoring by INL personnel. Process equipment engineering and design will be performed by INL personnel. All permit and safety assessment activities will be performed by INL personnel. Project management will be performed by INL personnel.

6. Schedule of Project Funding

(dollars in thousands)

	Prior Years	FY 2004	FY 2005	FY 2006	Out years	Total
Facility Design Cost						
Preliminary Design	0	0	0	3,100	8,700	11,800
Final Design	0	0	0	0	13,100	13,100
Project & Design Management...	0	0	0	0	2,400	2,400
Total PED	0	0	0	3,100	24,200	27,300
Other Project Costs						
Conceptual Design Cost	610	500	2,000	0	0	3,110
NEPA Documentation Costs	50	50	0	0	0	100
Other Project-Related Costs	860	0	0	0	0	860
Total Other Project Costs	1,520	550	2,000	0	0	4,070
Total PED and Other Project Costs	1,520	550	2,000	3,100	24,200	31,370

06-E-201, Gas Test Loop in the Advanced Test Reactor, Idaho National Laboratory (INL), Idaho

Significant Changes:

None.

1. Construction Schedule History

	Fiscal Quarter				Total Estimated Cost ($000)	Total Project Cost ($000)
	A-E Work Initiated	A-E Work Completed	Physical Construction Start	Physical Construction Complete		
FY 2006 Budget Request (PED/ Preliminary and Final Design Estimate…	1Q 2006	4Q2006	1Q 2007	2Q 2008	4,770	35,000
FY 2006 Budget Request (PDS, Pre-Conceptual Estimate)…	1Q 2006	4Q2006	1Q 2007	2Q 2008	22,400	35,000

2. Financial Schedule

(dollars in thousands)

Fiscal Year	Appropriations	Obligations	Costs
2006 (06-E-200)	4,770	4,770	4,770
2006	3,085	3,085	500
2007	10,765	10,765	11,600
2008	3,780	3,780	5,530

3. Project Description, Justification and Scope

Project Description

The Gas Test Loop Project will provide for the design, fabrication, assembly, start-up testing, and installation of a gas test loop assembly in the Advanced Test Reactor. The assembly will be installed in an existing flux trap and provide the capabilities to irradiate a wide variety of fuel and structural materials. These activities will be directed by the needs of the Advanced Fuel Cycle Initiative (AFCI) and Generation IV Nuclear Energy Systems (Gen IV) programs. Other nuclear fuels and materials testing programs (e.g., the Naval Reactors program) have expressed an interest in such a facility. Design and construction phases of the project will rely on the combined expertise of research and development and operations personnel at the INL.

Justification

Proper research and development of advanced nuclear fuels and materials requires an adequate irradiation facility to test candidate samples, uncover the underlying physical processes, and explore operational limits. In the world today, there exists no high flux gas environment testing facility capable of meeting the needs of the Department of Energy's proposed advanced fuel and reactor programs. Foreign testing capabilities lack required technical capabilities, require significant costly modifications, or are not projected to have availability and flexibility to support DOE's programs. A modification to an existing DOE test facility will best meet the needs of the programs. The Advanced Test Reactor (ATR) at the INL appears to be the best candidate to provide the required testing capability.

The system must meet certain requirements for test volume, instrumentation, radiation spectrum, and physical conditions characteristic of the anticipated operating environment. For the fuels and materials being explored as part of the AFCI and Gen IV initiatives, specific requirements include a fast neutron spectrum and the ability to achieve a wide range of temperatures under tightly controlled conditions. Certain materials testing reactors can provide proof-of-principle experimental capability as a step toward proof-of-performance testing with a prototypic spectrum. Studies have shown that fast-spectrum transmutation is most effective to meet the transmutation objectives for reducing minor-actinide inventories. A fast spectrum is also required to achieve desired damage rates in fuels without overheating the samples. The high fast flux levels of a fast spectrum irradiation system are also necessary to perform structural materials testing in a short enough period to meet program milestones.

Scope

A new Gas Test Loop (GTL) installed in a flux trap in the INL's Advanced Test Reactor (ATR) would provide a tightly controlled gaseous environment with the spectral characteristics and damage rates typical of a fast reactor. Features of the GTL include: gas-cooled test regions with user-specified temperature, pressure, and gas composition; enhanced neutron flux for simulating a fast reactor spectrum and accelerated neutron damage rates; sufficient volume to test a wide range of geometries; and sophisticated instrumentation for precise control of test conditions and on-line test monitoring.

Project scope includes the design, fabrication, and assembly of the GTL apparatus, and installation into ATR during an outage. Also included are Safety Analysis Report modifications, operating procedures, system testing, nuclear fuel procurement (if required), and project management and oversight.

FY 2006 funds will be used for initiation of construction activities including procurement of long lead items.

4. Details of Cost Estimate

	(dollars in thousands)	
	Current Estimate	Previous Estimate
Design Phase[a]		
Preliminary and Final Design Costs (Design Drawings and Specifications) (9.6% of TEC)	2,144	0
Design Management Costs (1.9% of TEC)	429	0
Project Management Costs (4.3% of TEC)	961	0
Total, Engineering Design Inspection and Administration of Construction Costs (15.8% of TEC)	3,534	0
Construction Phase		
Building Modifications & Equipment	12,230	0
Construction Management (0% of TEC)	N/A	N/A
Project Management (5.1% of TEC)	1,140	0
Total Construction Costs	13,370	0
Contingencies		
Design Phase (5.5% of TEC)	1,236	0
Construction Phase (19.0% of TEC)	4,260	0
Total, Contingencies (24.5% of TEC)	5,496	0
Total, Line Item Cost (TEC)	22,400	0

5. Method of Performance

Based on the unique aspects of ATR and oversight requirements for all activities at ATR, the operating contractor will need to be integrated into the project performance. Subcontracting will be utilized wherever feasible. The initial strategy is proposed as follows:

Design and inspection are performed via a joint effort by the operating contractor and outside negotiated subcontracts; if feasible, execution and procurement will be accomplished by fixed-price contracts and subcontracts awarded on the basis of competitive bidding, with the operating contractor completing the installation in ATR during required reactor outages.

[a] The design funds have been requested in a separate PED budget request (06-E-200).

6. Schedule of Project Funding

(dollars in thousands)

	FY 2004	FY 2005	FY 2006	Outyears	Total
Project Cost					
Facility Cost					
Design	0	0	4,770	0	4,770
Construction	0	0	500	17,130	17,630
Total, Line Item TEC	0	0	5,270	17,130	22,400
Other Project Costs					
Conceptual design costs	207	6,214**	0	0	6,421
NEPA Documentation Costs	0	0	0	0	0
Other project-related costs	338	0	2,000	3,841	6,179
Total, Other Project costs	545	6,214	2,000	3,841	12,600
Total, Project Costs	545	6,214	7,270	20,971	35,000

** Note: This includes a Congressional earmark of up to $2,000,000 of operating funds appropriated to the Naval Reactors Program.

7. Related Annual Funding Requirements

(FY 2006 dollars in thousands)

	Current Estimate	Previous Estimate
Average Annual Facility Operating Costs (includes escalation & contingency)	9,000	N/A
Total Related Annual Funding	9,000	N/A
Total Operating Costs (operating from FY 2009 through FY 2028)	180,000	N/A

Program Direction

Funding Profile by Category

(dollars in thousands/whole FTEs)

	FY 2004	FY 2005	FY 2006	$ Change	% Change
Program Direction					
Salaries and Benefits	45,088	45,826	46,673	+847	+1.8%
Travel	2,011	2,167	2,167	+0	+0.0%
Support Services	3,953	2,700	2,700	+0	+0.0%
Other Related Expenses	8,946	9,342	9,569	+227	+2.4%
Total Program Direction, Energy Supply and Other Defense Activities	59,998	60,035	61,109	+1,074	+1.8%
Headquarters FTEs	142	146	151	+5	+3.4%
Field FTEs	224	217	211	-6	-2.8%

Funding Profile by Category - Energy Supply

(dollars in thousands/whole FTEs)

	FY 2004	FY 2005	FY 2006	$ Change	% Change
Program Direction – Energy Supply					
Salaries and Benefits	20,347	21,457	22,881	+1,424	+6.6%
Travel	1,036	1,167	1,192	+25	+2.1%
Support Services	3,106	1,830	1,853	+23	+1.3%
Other Related Expenses	1,530	2,062	4,080	+2,018	+97.9%
Total Program Direction – Energy Supply	26,019	26,516	30,006	+3,490	+13.2%
Headquarters FTEs	142	146	151	+5	+3.4%
Field FTEs	23	14	14	+0	+0.0%

Funding Profile by Category - Other Defense Activities

(dollars in thousands/whole FTEs)

	FY 2004	FY 2005	FY 2006	$ Change	% Change
Program Direction – Other Defense Activities					
Salaries and Benefits	24,741	24,369	23,792	-577	-2.4%
Travel	975	1,000	975	-25	-2.5%
Support Services	847	870	847	-23	-2.6%
Other Related Expenses	7,416	7,280	5,489	-1,791	-24.6%
Total Program Direction – Other Defense Activities	33,979	33,519	31,103	-2,416	-7.2%
Headquarters FTEs	0	0	0	+0	+0.0%
Field FTEs	201	203	197	-6	-3.0%

Program Direction
Funding Profile by Category

(dollars in thousands/whole FTEs)

	FY 2004	FY 2005	FY 2006	$ Change	% Change
Idaho Operations Office					
Salaries and Benefits	25,920	24,369	23,792	-577	-2.4%
Travel	1,061	1,000	975	-25	-2.5%
Support Services	925	870	847	-23	-2.6%
Other Related Expenses	5,469	5,996	5,489	-507	-8.5%
Total, Idaho Operations Office	33,375[a]	32,235	31,103	-1,132	-3.5%
Full Time Equivalents	210	203	197	-6	-3.0%
Oak Ridge Operations Office					
Salaries and Benefits	1,661	1,729	1,800	+71	+4.1%
Travel	49	50	51	+1	+2.0%
Support Services	73	58	53	-5	-8.6%
Other Related Expenses	113	120	128	+8	+6.7%
Total, Oak Ridge Operations Office	1,896	1,957	2,032	+75	+3.8%
Full Time Equivalents	14	14	14	+0	+0.0%
Headquarters					
Salaries and Benefits	17,507	19,728	21,081	+1,353	+6.9%
Travel	901	1,117	1,141	+24	+2.2%
Support Services	2,955	1,772	1,800	+28	+1.6%
Other Related Expenses	3,364	3,226	3,952	+726	+22.5%
Total, Headquarters	24,727	25,843	27,974	+2,131	+8.2%
Full Time Equivalents	142	146	151	+5	+3.4%
Total Program Direction					
Salaries and Benefits	45,088	45,826	46,673	+847	+1.8%
Travel	2,011	2,167	2,167	+0	+0.0%
Support Services	3,953	2,700	2,700	+0	+0.0%
Other Related Expenses	8,946	9,342	9,569	+227	+2.4%
Total, Program Direction, Energy Supply and Other Defense Activities	59,998	60,035	61,109	+1,074	+1.8%
Full Time Equivalents	366	363	362	-1	+0.3%

[a] For comparability purposes, funding for 6 FTEs at the Chicago and 1 FTE at the Oakland Operations Offices have been included in the Idaho Operations Office.

Mission

Program Direction provides the Federal staffing resources and associated costs required to provide overall direction and execution of the Office of Nuclear Energy, Science and Technology (NE). NE promotes secure, competitive, and environmentally responsible nuclear technologies to serve the present and future energy needs of the country. NE carries out this mission in several ways. As the central organization with the Federal Government's core expertise in nuclear technology, NE directs the Nation's investment in nuclear science and technology by sponsoring research at the national laboratories, U.S. universities, and private industry. Through its support of innovative, higher risk science and by helping to preserve the national research and development infrastructure, NE works to advance the responsible use of nuclear technology. NE also manages the safe operation and maintenance of critical nuclear infrastructure and provides nuclear technology goods and services to industry and government.

In addition to our appropriated funds, NE also manages over $230 million dollars annually in work for others and reimbursable funding. For example, NE manages over $110 million annually from the National Aeronautics and Space Administration and the Department of Defense for the development of advanced radioisotope power systems for space exploration and national security missions. In addition, NE manages the High Flux Isotope Reactor for the Office of Science.

NE is one of the most programmatically diverse organizations in the Department of Energy (DOE) and is faced with critical human capital challenges to pursuing its mission. Extensive downsizing several years ago resulted in numerous skill imbalances and particularly affected NE's retention of technical and scientific specialists. Wherever possible, employees were redeployed from lower priority programs to higher priority programs to meet mission needs. At this point, with expanding programs, limited resources, and skill imbalances, NE faces a variety of staffing challenges as it works to meet the requirements set for it by the President and the Secretary of Energy.

NE's human capital vision is to develop, recruit, and maintain a diverse organization of highly skilled professionals with the competency and motivation to contribute to the development and implementation of national energy policies and programs and help lead the Nation in achieving its nuclear technology goals for the twenty-first century.

In May 2003, NE assumed the role of Lead Program Secretarial Officer (LPSO) of the Idaho site. NE Headquarters and the Idaho Operations Office (NE-ID) reorganized in January 2005 to more effectively support the new nuclear energy missions and prepare for the oversight and management of the new contracts for the operation of the Idaho site. This new structure will carry out all programmatic, project, and landlord responsibilities assigned to NE now and in the future, both as LPSO and Contracting Officer for DOE's operations in Idaho, and as responsible PSO for programs, projects, facilities, and operations at other DOE sites. In addition, NE is aggressively addressing the mismatch between the growth in its national responsibilities and the decline in its skilled personnel. The Office of Nuclear Energy, Science and Technology Workforce Plan was updated in December 2004 to reflect mission changes and skills imbalances. Like the rest of the Federal Government, NE is planning for workforce changes that are engendered by an aging workforce. The average age of the NE workforce is 48 years, just slightly higher than the 47.5 year average age of the Federal workforce overall. Out of the current workforce, over one-third of the workforce will be eligible to retire within five years. Over the past

several years, NE has been trying to address the issue of an aging workforce through the recruitment of entry-level engineering, scientific, and administrative positions. Continuation of this effort is essential. The NE Workforce Plan indicates that, especially in the area of program and project management, and mission-critical positions (engineers and scientists), NE has a skills mix problem that must be addressed in the near term, as well as a need to increase staffing. In accordance with the NE Workforce Plan, NE plans a moderate increase in the Headquarters workforce over the next five years. The required staffing level is restrained because NE expects to continue its successful practice of aggressive matrix management and assuring the fullest possible utilization of staff resources. The proposed actions from the NE Workforce Plan plus NE's evolving mission create small, additional requirements for Program Direction funds. However, as in the past, NE's Program Direction budget is developed to cover special programs and circumstances such as A-76/competitive outsourcing; special incentive programs to retain necessary/essential skills; succession planning; train and/or retrain; and participate in special employment programs.

OMB allocated funds to ask the National Academy of Sciences to undertake a comprehensive, independent evaluation of the nuclear energy program's goals, plans, and to validate the process of establishing program priorities and oversight (including the method for determining the relative distribution of budgetary resources). The evaluation will result in a comprehensive and detailed set of policy and research recommendations and associated priorities (including performance targets and metrics) for an integrated agenda of research activities that can best advance NE's fundamental mission of securing nuclear energy as a viable, long-term commercial energy option to provide diversity in energy supply. An interim evaluation will be completed in time to inform NE's 2008 budget planning, with a final report completed before May 2006.

Detailed Justification

(dollars in thousands)

	FY 2004	FY 2005	FY 2006
Salaries and Benefits	**45,088**	**45,826**	**46,673**

NE Headquarters has retrained and redeployed staff to reduce dependence on contractors; and continuously redirected and realigned staff to accomplish program goals efficiently and effectively. However, NE's expanding role in the Department to support the *National Energy Policy* and to improve the proliferation-resistance of civilian nuclear energy systems will require additional staff. In addition, staff will be needed to assure the safe operation of the Department's various reactor facilities and provide adequate Federal oversight of essential programs. NE believes that it is essential to hire not only senior engineers and project managers for new and changing programs, but also to recruit junior staff for succession planning purposes; efforts to hire additional junior staff are continuing. NE Headquarters currently has a staff of 129. As nearly one-third of the staff will be eligible to retire within five years, it is essential that program direction resources are available to compete for needed skills. In addition to the Headquarters staff, NE also supports one employee who serves on the staff of the U.S. mission to the Organization for Economic Cooperation and Development; and field employees in two locations: the Idaho Operations Office (197), and Oak Ridge Operations Office (14). Additionally, in support of the

(dollars in thousands)

FY 2004	FY 2005	FY 2006

Department's efforts to consolidate information technology activities, one NE employee was permanently reassigned to the Office of the Chief Information Officer. NE agreed to continue funding for this position/employee through FY 2005. Also, in FY 2006 NE will assume responsibility for two FTEs transferred from the Office of Defense Nuclear Nonproliferation in support of the International Nuclear Safety activities.

Travel **2,011** **2,167** **2,167**

Travel includes funding for transportation of Headquarters and operations office personnel associated with NE programs, their per diem allowances while in authorized travel status, and other expenses incidental to travel.

Support Services **3,953** **2,700** **2,700**

Support Services includes funding for technical and management support services provided to NE Headquarters and Operations Office employees. NE requires its senior technical managers to be Federal employees with significant experience necessary to accomplish program objectives. NE does not rely on support service contractors to manage NE programs in place of Federal staff. To reduce support services costs, NE has retrained and redeployed staff to reduce dependence on contractors while meeting growing needs in programs such as Generation IV Nuclear Energy Systems Initiative and Nuclear Hydrogen Initiative. In this manner, NE has minimized support service costs over the last five years.

Other Related Expenses **8,946** **9,342** **9,569**

The major expenditure in the other related expenses category is $2,232,000 million in FY 2006 and is earmarked for the Headquarters Working Capital Fund (WFC). The Department's Office of Management, Budget, and Evaluation established a WCF to provide funding for mandatory administrative costs, such as building occupancy and telephone services, copying, printing and graphics, networking, desktop support, procurement management, payroll and personnel, corporate training services, and project management career development program. The Other Related Expense category also includes support for the Nuclear Energy Research Advisory Committee and funding for the National Academy of Sciences to undertake a comprehensive, independent evaluation of NE's research programs, including their relationship to the Idaho Facilities Management program.

Also included in other expenses are costs associated with the one employee who serves on the staff of the Organization for Economic Cooperation and Development such as housing, training, office communications, supplies, miscellaneous expenses and International Cooperative Administrative Support Services (ICASS).

Total, Program Direction **59,998** **60,035** **61,109**

Explanation of Funding Changes

	FY 2006 vs. FY 2005 ($000)
Salaries and Benefits	
▪ The increase of $847,000 is the net of an additional $750,000 for new hires at Headquarters to manage expanding research and development programs, such as the Nuclear Hydrogen Initiative and Generation IV Nuclear Energy Systems Initiative to support the Department's nuclear non-proliferation objectives, while simultaneously preparing for a significant number of retirements over the coming five years; an additional $893,000 for a 2.5 percent escalation in accordance with established guidelines and funds for promotions and within-grade salary increases; and a decrease of $796,000 for a reduction of 6 field FTEs at Idaho.	+847
Other Related Expenses	
▪ The increase of $227,000 in other related expenses is primarily due to an increase of $1,000,000 in funding for the National Academy of Sciences to undertake a comprehensive, independent evaluation of NE's research programs; an increase of $121,000 for utilities, training, supplies and materials, and communications; offset by a reduction of $889,000 at Idaho for completing the purchase of telecommunications equipment in FY 2005, and reduced medical expense and mailroom services.	+227
Total Funding Change, Program Direction	**+1,074**

Support Services by Category

(dollars in thousands)

	FY 2004	FY 2005	FY 2006	$ Change	% Change
Technical Support					
System Definition	25	0	0	+0.0	+0.0%
System Review and Reliability Analyses	58	150	150	+0.0	+0.0%
Trade-off Analyses	145	138	138	+0.0	+0.0%
Economic and Environmental Analyses	230	135	135	+0.0	+0.0%
Test and Evaluation	50	50	50	+0.0	+0.0%
Surveys or Reviews of Technical Operations	300	0	0	+0.0	+0.0%
Total, Technical Support	808	473	473	+0.0	+0.0%
Management, Support					
Automated Data Processing	1,632	1,540	1,540	+0.0	+0.0%
Preparation of Program Plans	71	37	37	+0.0	+0.0%
Training and Education	425	0	0	+0.0	+0.0%
Reports and Analyses Management and General Administrative Services	1,017	650	650	+0.0	+0.0%
Total, Management Support	3,145	2,227	2,227	+0.0	+0.0%
Total, Support Services	3,953	2,700	2,700	+0.0	+0.0%

Other Related Expenses by Category

(dollars in thousands)

	FY 2004	FY 2005	FY 2006	$ Change	% Change
Other Related Expenses					
Working Capital Fund	2,068	2,237	2,232	-5	-0.2%
Advisory and Assistance Services	400	200	1,200	+1,000	+500.0%
Operations and Maintenance of Equip	4,148	4,240	3,556	-684	-16.1%
Printing and Reproduction	33	33	33	+0	+0.0%
Training	304	316	331	+15	+4.8%
Rent and Utilities	963	1,217	1,225	+8	+0.6%
Communications	541	433	528	+95	+21.9%
Supplies and Materials	400	447	450	+3	+0.7%
Other Services	89	219	14	-205	-93.6%
Total, Other Related Expenses	8,946	9,342	9,569	+227	+2.4%